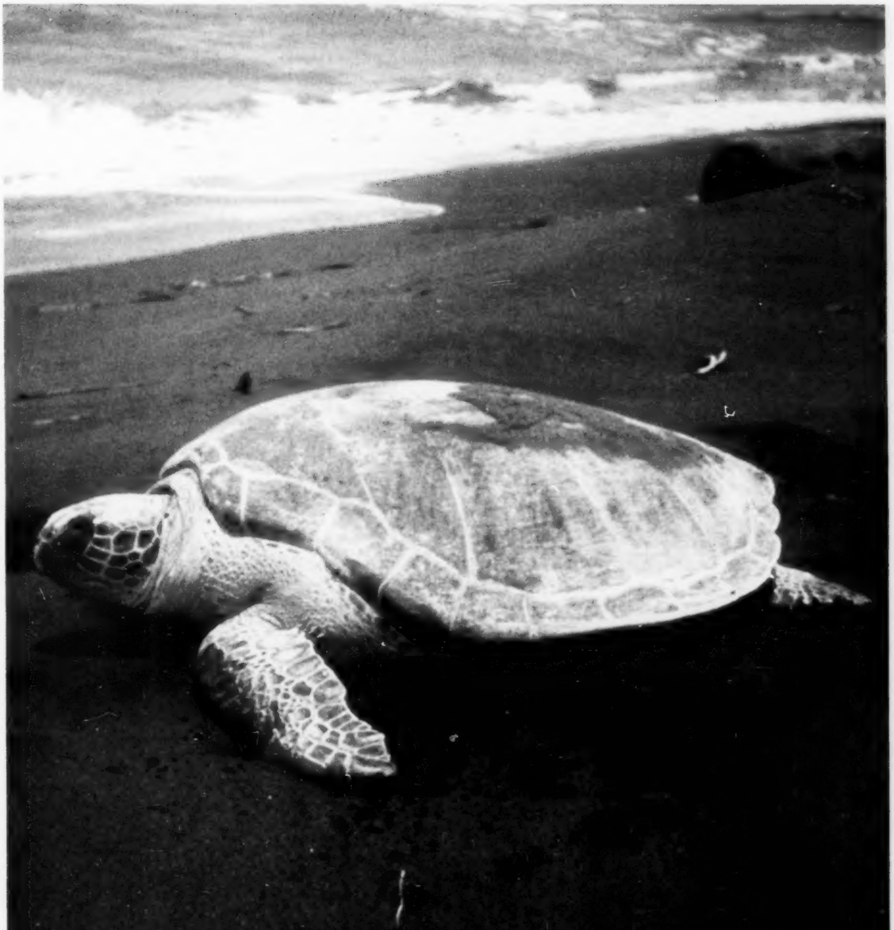
Marine Fisheries REVIEW

Vol. 50, No. 3
1988

National Oceanic and Atmospheric Administration • National Marine Fisheries Service



Sea Turtle Studies

Marine Fisheries REVIEW

On the cover: Green sea turtle photo by Larry Ogren, NMFS SEFC Panama City Laboratory, Panama City, Fla.

Articles *50(3), 1988*

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The *Marine Fisheries Review* (ISSN 0090-1830) is published quarterly by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Bin C15700, Seattle, WA 98115. Single copies and annual subscriptions are sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402: Single copy, $3.75 domestic, $4.69 foreign; annual subscription, $7.00 domestic; $8.75 foreign.

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"Bone Softening," a Practical Way to Utilize Small Fish

M. OKADA, T. MACHINO, and S. KATO

Introduction

Many of the fishery resources available on the U.S. west coast are being harvested at maximal levels. To increase fisheries production, there is a need to turn to presently underutilized species. Reasons for not using certain fishes are varied, but small size is frequently cited as one of the chief impediments. This is principally because most Americans, and indeed people throughout much of the world, are accustomed to eating boneless fillets of fish, and small fish are usually uneconomical to debone or fillet.

Even in Japan, where per-capita fish consumption is about 5 times that of the United States, small fishes present problems in utilization. Thus, the enormous catch of sardines there (more than 4 million tons in 1986) is used primarily for fish meal rather than for direct human consumption. Looking for ways to increase direct consumption of sardines and other small fishes, Japanese researchers considered various alternatives. One of the more successful products developed was "bone-softened" fish, which utilized small fish that were "dressed," i.e., head, tail, and viscera removed, but with skeletal bones, spines, and some scales left intact. The obvious advantages of using dressed fish rather than fillets are higher yield and lower processing costs. A further advantage may be in increased nutritional value, as bone is a good source of many essential minerals, particularly calcium.

In the fall of 1986, JAC Creative Foods, Inc.[1], Los Angeles, Calif., and the West Coast Fisheries Development Foundation, Portland, Oreg., obtained a Saltonstall-Kennedy fisheries development grant from the National Marine Fisheries Service to study ways to increase utilization of certain California fishes. One aspect of this project was to study bone softening techniques using small species of fish that are abundant off the California coast. The principal objectives were to learn if hard parts (bones, scales, and spines) of these species could be softened so that they would be undetectable when eaten, and to attempt to manufacture products made with bone-softened fish that are palatable to American tastes. This paper presents findings of that study to provide the fishing industry as well as consumers with information about the production and consumption of bone-softened fish.

Materials and Methods

Most of the fish used in this study were caught with bottom trawls and were provided by fishermen from Monterey and Morro Bay, Calif. Species included shortbelly rockfish, *Sebastes jordani*; Pacific sanddab, *Citharichthys sordidus*; white croaker, *Genyonemus lineatus*; plainfin midshipman, *Porichthys notatus*; rex sole, *Glyptocephalus zachirus*; English sole, *Parophrys vetulus*; Dover sole, *Microstomus pacificus*; and ratfish, *Hydrolagus colliei*. Additionally, samples of so-called "small pelagic species" (i.e., jack mackerel, *Trachurus symmetricus*; Pacific mackerel, *Scomber japonicus*; and Pacific sardine, *Sardinops sagax*) caught off southern California with roundhaul nets, were obtained from wholesale fish dealers in Los Angeles. Specimens of yellowfin tuna, *Thunnus albacares*; and goosefish, *Lophius americanus* (often called "monkfish"), which were used in two comparative experiments were also purchased at a wholesale fish market. All fish except the last two and the ratfish were smaller than 28 cm (11 inches) in total length.

Processing operations and most evaluation procedures were carried out at two fish processing plants in Los Angeles, JAC Creative Foods and Yamasa Enterprises. For each experiment, frozen fish were thawed at room temperature, then measured and weighed. They were then dressed, and the visceral cavity scrubbed clean. After being weighed a second time to determine the amount of waste, several fish were lined in a single layer, wrapped in aluminum foil[2], and cooked in a laboratory-sized autoclave. The cooker was a Barnstead Benchtop Autoclave, with a chamber 39×25 cm (15½×10 inches), and a capacity of around 1.15 kg (2.5 pounds) of material. Pressure within the chamber was dictated by the experimental temperature, i.e., the pressure was constant for each chosen cooking temperature: At 116°C, the pressure was 0.7 kg/cm^2 or k.s.c. (240°F, 10 pounds/inch^2 or p.s.i.); at

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[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

[2]This was necessary only because the small autoclave used in this study could not accommodate juices that emanated during processing. Commercial operations would utilize open racks.

121°C, 1.05 k.s.c. (250°F, 15 p.s.i.); at 127°C, 1.40 k.s.c. (260°F, 20 p.s.i.); at 132°C, 1.75 k.s.c. (270°F, 25 p.s.i.). Fish prepared for outside evaluation were cooked in an autoclave that was similar, but with slightly greater capacity.

Experiments were also conducted to attempt to improve the texture and moistness of bone-softened fish. These trials entailed pretreatment of the fish by soaking dressed fish overnight in cold salt (sodium chloride) brine solution of various concentrations. The samples and solutions were kept refrigerated at about 5°C (41°F). Other treatments tried were addition of varied amounts of citric acid or sodium tripolyphosphate (TPP) to vary the pH level of the soaking solution.

To remove the "fishy" odor of some species, we used extracts of powdered Japanese green tea in salt brine solution. Various amounts of tea were steeped in 800 ml (1.06 quarts) of tap water at 95°C (203°F) for 30 minutes. The tea solution was then filtered through cheese cloth and enough water was added to make up a volume of 1 liter. Test fish were soaked in the tea solution overnight. About 1.2 kg (2.6 pounds) of fish were treated in 1 liter of solution. Different species were kept in separate containers.

The cooked samples were drained, and allowed to cool. For most tests the extent to which the bones were softened was determined by having a number of persons (usually five, including the first two authors and three plant personnel) eat the samples of processed fish and report whether the hard parts were: 1) Detectable when eaten, 2) slightly noticable when eaten, or 3) undetectable when eaten. A fourth, nonorganoleptic measure was also used: 4) Bones crumble easily after slight finger pressure. Both items 3 and 4 were considered desirable endpoints of our experiments. Evaluation of other attributes such as texture and moistness was made by the first two authors.

Chemical analyses of bone-softened shortbelly rockfish and jack mackerel were carried out by a private firm, Michelson Laboratories, Inc., 6280 Chalet Drive, Commerce, CA 90040. Samples of both species were dressed, then soaked overnight in brine solution (1.5 percent salt for shortbelly rockfish and 2 percent for jack mackerel) which also contained 0.25 percent tea solution. In addition, the soaking solution for jack mackerel included 0.25 percent TPP. One liter of solution was used for each 1.2 kg of fish. After soaking, the fish were cooked in an autoclave at 121°C and 15 p.s.i. for 40 minutes. For each analysis, two fish of each species were ground and blended together.

Formal organoleptic evaluation of bone-softened shortbelly rockfish and jack mackerel was conducted by a taste panel composed of members of the staff of the Utilization Research Division, NMFS Northwest and Alaska Fisheries Center, Seattle, Wash. The panel members were trained to conduct such tests.

Results

Bone Softening

Effects of Cooking Temperature and Pressure

Ten species of fish were cooked for a constant time (40 minutes) at varied temperatures and pressures to learn the effects of these treatments on softening bones, scales, and spines. Of the four temperatures and pressures used, the lowest (116°C; 10 p.s.i.) was sufficient to soften the bones of most fish satisfactorily (Table 1). At 121°C, only the midshipman failed to attain a good score (3 or 4). Increasing temperature (and pressure) clearly resulted in greater softening of hard parts.

Vertebral bones of shortbelly rockfish and white croaker were somewhat more difficult to soften than the other fishes. Bones of the small pelagic species (mackerels and sardines) were easily softened, as were those of small flatfish (rex, Dover, and English soles) and Pacific whiting.

Effects of Cooking Temperature, Pressure, and Time

Samples of jack mackerel whose average weight was around 104 g (0.23 pound) were cooked at 110°, 116°, and 121°C for 25-50 minutes. Prolonged cooking time did not result in increased softening of bone (Table 2). On the other hand, increasing the cooking temperature from 110° to 116° and 121°C markedly softened the bones, as was found in the first experiment. At 116°C a cooking time of 25 minutes was sufficient to soften bones of jack mackerel.

Effects of Fish Size

Samples of Pacific mackerel and shortbelly rockfish were separated into three size groups and cooked at three temperatures for a constant time. The results (Table 3) indicated that within the

Table 1.—Extent of softening of bone with varied temperatures and pressures. Cooking time was 40 minutes. Numerals are average scores of five tasters, and correspond to: 1 = bone detectable when eaten, 2 = barely detectable when eaten, 3 = not detectable when eaten, and 4 = bone crumbles easily when rubbed between the fingers.

	Cooking temperature (°C) and pressure (p.s.i.)			
Species	116° (10)	121° (15)	127° (20)	132° (25)
Plainfin midshipman	1	2	3	4
White croaker	2	3	4	4
Shortbelly rockfish	2	3	4	4
Pacific whiting	3	4	4	4
Pacific mackerel	3	4	4	
Pacific sardine	3	4	4	
Jack mackerel	3	4	4	
Dover sole	3	4	4	
English sole	3	4	4	
Rex sole	3	4	4	

Table 2.—Effects of cooking time, temperature and pressure on softening bones of jack mackerel. The scoring system is the same as that given in Table 1.

	Cooking temperature (°C) and pressure (p.s.i.)		
Cooking time (minutes)	110°C (5)	116°C (10)	121°C (15)
25	2	3	4
30	2	3	4
45	2	3	4
50	2	3	4

Table 3.—Effects of fish size and cooking temperature on extent of bone softening. Cooking time was 45 minutes. The scoring system is the same as that used in Table 1.

		Cooking temp. (°C)		
Species	Fish size (total weight)	110°	116°	121°
Pacific mackerel	Lg. (580 g; 1.28 lb)	2	3	4
	Med. (265 g; 0.56 lb)	2	3	4
	Sm. (167 g; 0.37 lb)	2	3	4
Shortbelly rockfish	Lg. (295 g; 0.65 lb)		1	3
	Med. (205 g; 0.45 lb)		1	3
	Sm. (100 g; 0.22 lb)		1	3

range of sizes tested, fish size was not related to cooking temperature (110°, 116°, and 121°C) with respect to degree of softening of bone. The minimum temperature required was the same for large as well as small individuals. Apparently the specific composition of the bone was more important than fish size in determining whether the bones became soft.

Minimum Cooking Temperatures

Cleaned vertebrae of nine species were cooked at various temperatures for 30 minutes to learn the minimum temperature necessary to soften vertebrae. As before, the test samples were eaten (in this test only by the first two authors) and given a numerical score correlated with the tasters' ability to sense the texture of bone. The vertebrae were also rubbed between the fingers to determine softness. Tuna vertebrae were the most difficult to soften and goosefish vertebrae were the easiest (Table 4). A cooking temperature of 121°C was sufficient to soften bones of nearly all species tested. Shortbelly rockfish bones required a slightly higher temperature to attain a satisfactory degree of softness.

To further study the relationship between bone composition and cooking time needed to soften the bone, the vertebrae of several species of fish were boiled and thoroughly cleaned and dried, and sent to Michelson Laboratories for analyses of chemical composition. Results of the analyses of calcium and nitrogen content of the bone are given in Table 5, along with the minimum temperature needed to soften the vertebae (from Table 4). No correlation between calcium or nitrogen content and the amount of heat necessary for softening bone was evident. English sole vertebrae had the highest calcium content, yet a relatively low temperature was sufficient to soften it. Also, shortbelly rockfish and goosefish bones were similar in calcium content, but the latter's vertebrae were much more easily softened.

Table 4.—Minimum temperatures needed to soften vertebrae of fishes. After most flesh was removed, segments of vertebrae were cooked for 30 minutes in an autoclave.

Species	Min. temp. (°C)	Score	Comments
Yellowfin tuna	>127°	1	Bone only slightly softened
Shortbelly rockfish	>121°	2	At 121°C slightly gritty
Pacific sardine	121°	3	
Dover sole	121°	3	
Pacific mackerel	>116°	2	At 116°C slightly gritty
English sole	>116°	2	At 116°C slightly gritty
Jack mackerel	116°	3	
Ratfish	110°	3	
Goosefish	<110°	4	At 110°C bone crumbles easily

Table 5.—Calcium and nitrogen content (percent of total vertebral weight) of vertebrae of some fishes, and the minimum temperature necessary to soften bone. Time of cooking in the autoclave was 30 minutes.

Species	Calcium (Ca)	Total nitrogen (N)	Ca/N	Min. temp. (°C)
Yellowfin tuna	21.5%	4.42%	4.86	>127°
Shortbelly rockfish	18.5	2.67	6.93	>121°
Dover sole	14.8	2.46	6.02	121°
Pacific mackerel	13.7	2.29	5.98	>116°
English sole	26.1	2.96	8.82	>116°
Ratfish	7.5	9.71	0.77	110°
Goosefish	17.5	5.75	3.04	<110°

Table 6.—Effect of tea concentration on deodorization of Pacific sardine and jack mackerel. Fish were tested organoleptically after being soaked in the tea solution overnight, then cooked for 40 minutes at 121°C.

Grams of tea in 1 liter of water	Pacific sardine	Jack mackerel
0[1]	Very fishy	Fishy
2	Slightly fishy	Slightly fishy
2.5	No fishy odor	No fishy odor
3	No fishy odor	No fishy odor
5	No fishy odor	No fishy odor
10	No fishy odor, but slight tea odor	No fishy odor, but but slight tea odor

[1]Control.

Table 7.—Effect of citric acid in reducing ammonia odor of bone-softened fish. Dressed fish were soaked in chilled 2.5 percent brine solutions overnight, then cooked for 30 minutes at 121°C.

	Citric acid concentration (%)		
Species	0.0	0.1	0.3
Shortbelly rockfish	Slight ammonia odor	No ammonia odor	No ammonia odor
Pacific whiting	Ammonia odor	Slight ammonia odor	No ammonia odor

Deodorization

Preliminary tests showed that solutions of Chinese black tea and oolong tea and Japanese green tea were all effective in deodorizing the flesh of small pelagic species. However, we found that Chinese teas imparted a noticably dark stain on the fish flesh, so their use was discontinued. After the fish were soaked overnight in green tea solution, they were cooked at 121°C for 40 minutes. The effects of soaking fish in various concentrations of green tea solutions on the flesh of Pacific sardine and jack mackerel are given in Table 6. An amount of 2.5 g of green tea in 1 liter of water (2.5‰) was sufficient to deodorize at least 1 kg of small pelagic species. When a tea solution of 10‰ was used, an odor and taste of tea was imparted to the flesh.

When cooked in an autoclave, bottomfish were inherently less "fishy-smelling" than small pelagic species. Both shortbelly rockfish and Pacific whiting emitted a slight ammonia odor, however, and the odor was even stronger in midshipman. White croaker and flatfish had a slight but unobjectionable odor. To reduce the ammonia odor in shortbelly rockfish and Pacific whiting we tried a treatment of citric acid solution. Dressed fish were soaked overnight in chilled 2.5 percent brine solutions containing citric acid, then cooked in the autoclave for 30 minutes at 121°C. Organoleptic evaluation of the cooked fish revealed that a 0.1 percent solution was sufficient to remove the ammonia odor in shortbelly rockfish, while a 0.3 percent solution was required for Pacific whiting (Table 7).

Texture and Moistness

Treatments tested for improving texture and moistness of bone-softened fish included variations in cooking temperature, pH level of the cooked flesh, and salt concentrations of brine solutions. The flesh of jack mackerel soaked overnight in a 2 percent salt solution before cooking was juicy and firm compared to the control (no salt) which was watery and soft (Table 8). A 1.5 percent solution was not effective, while a 3.0 percent salt solution resulted in drier flesh

Table 8.—Effects of different concentrations of salt solutions on texture and moistness of bone-softened fish. The dressed fish were soaked in the solutions overnight, then cooked at 121°C for 40 minutes.

Amt. of salt (%)	Jack mackerel	Pacific sardine	Flatfish
0[1]	Watery Soft	Watery Soft	Watery Soft
1.5	Watery Soft	Watery Somewhat firm	Watery Somewhat soft
2.0	Moist Firm	Somewhat watery Firm	Somewhat mushy
2.5	Moist Firm	Moist Firm	Somewhat mushy
3.0	Dry Firm	Somewhat dry Firm	Mushy

[1]Control.

Table 9.—Texture and moistness of bone-softened fish at varied cooking temperatures. Fish were soaked in 2.5 percent salt solution overnight, then cooked for 40 minutes in an autoclave.

	Characteristics of cooked flesh at specified cooking temperatures		
Species	116°C	121°C	127°C
Pacific sardine	Moist Somewhat soft	Watery Firm	Watery Firm
Jack mackerel	Moist Firm	Dry Firm	Dry Firm
Shortbelly rockfish	Moist Firm	Moist Somewhat soft	Dry Soft
Flatfish	Moist Somewhat firm	Watery Mushy	Watery Mushy

Table 10.—Effect of pH adjustment on texture and moistness of bone-softened fish. Fish were soaked overnight in 2.5 percent salt brine solution, and citric acid (CA) or sodium tripolyphosphate (TPP) was used to adjust pH. Fish were then cooked at 121°C for 40 minutes in an autoclave.

	Characteristics of cooked flesh			
Treatment	Jack mackerel	Pacific sardine	Dover sole	Pacific whiting
Control (2.5% salt)	pH 6.31 somewhat dry; firm	pH 6.15 somewhat dry and watery	pH 6.75 mushy and watery	pH 7.11 soft; somewhat watery
+0.3% TPP	pH 6.51 moist; firm	pH 6.34 moist; somewhat soft	pH 6.95 very mushy	
+0.1% CA			pH 6.66 somewhat soft; moist	pH 7.02 somewhat soft and watery
+0.2% CA			pH 6.60 somewhat firm; moist	pH 6.85 firm; somewhat dry
+0.3% CA	pH 5.80 very dry; firm	pH 5.67 dry; firm		

and was judged to be not as good as that prepared with a 2.0 percent salt solution. Pacific sardine required a 2.5 percent salt brine to produce moist and firm flesh. The flesh of several species of flatfish did not improve with the addition of salt, however, and in fact the texture was markedly worsened as more salt was used.

To test the effects of cooking temperature, dressed fish were soaked overnight in a 2.5 percent salt solution, then cooked separately at three levels of heat and pressure for 40 minutes. The lowest temperature used (116°C) generally resulted in the best texture and moistness in the flesh of the fish tested (Table 9). The flesh qualities of all species of flatfish were significantly better when cooked at 116°C. Unfortunately, somewhat higher temperatures are needed to soften the bones of some species (Table 1).

To learn the effects of pH on texture and moistness of bone-softened fish, we soaked several dressed fish overnight in solutions that contained 2.5 percent salt, and either citric acid or sodium tripolyphosphate (TPP), then cooked the fish at 121°C for 40 minutes. The pH of the cooked fish was then measured and the fish tested organoleptically. The results (Table 10) indicated that addition of 0.3 percent TPP effectively increased moistness in jack mackerel and Pacific sardine, but caused Dover sole flesh to become very mushy. When the pH was lowered by addition of citric acid, the flesh of jack mackerel and Pacific sardine became too dry. Conversely, the same treatment caused an improvement in texture of Dover sole and Pacific whiting and there was also a noticable improvement in reduction of objectionable odor.

Proximate Analysis

The compositions of dressed and cooked shortbelly rockfish and jack mackerel caught in October are given in Table 11. Prior to cooking, shortbelly rockfish was soaked overnight in 1.5 percent and jack mackerel in 2.0 percent brine solutions. The percentages of total protein, 22.45 percent and 25.71 percent for shortbelly and jack mackerel respectively, were relatively high due to a reduction in moisture content from brine soaking and cooking. The calcium level was high as expected because of the presence of bone, and sodium was elevated by the brine treatment.

Table 11.—Proximate composition of bone-softened shortbelly rockfish and jack mackerel. The fish were dressed, and cooked in an autoclave at 121°C and 15 p.s.i. for 40 minutes. Results are expressed in percent of dressed weight, or as otherwise indicated.

Item	Shortbelly rockfish	Jack mackerel
Moisture (%)	71.09	70.46
Total protein (%)	22.45	25.71
Fat (ether extract, %)	4.54	2.35
Ash (%)	1.67	1.65
Calories/100 g	132.00	124.00
Calcium (mg/100 g)	291.00	94.20
Sodium (mg/100 g)	138.00	239.00

Product Yield

The yields of bone-softened shortbelly rockfish and jack mackerel are given in Table 12. Shortbelly rockfish yield, 37.5 percent of the initial weight, was low compared to that for jack mackerel, 45.7 percent. Some of the weight loss for shortbelly rockfish is attributible to our processing and handling methods as considerable amounts of the soft cooked flesh fell apart and was lost during removal from the aluminum foil pouch. The moisture contents of both species are similar, averaging 76 and 75

Table 12.—Product yield for bone-softened shortbelly rockfish and jack mackerel. The fish were soaked overnight in brine solutions and cooked at 121°C and 15 p.s.i. for 40 minutes (shortbelly rockfish) or 30 minutes (jack mackerel).

Item	Shortbelly rockfish	Jack mackerel
Avg. total length	208 mm (8.2 in.)	250 mm (9.8 in.)
Avg. total wt.	88 g (3.1 oz.)	164 g (5.8 oz.)
Avg. dressed length	111 mm (4.4 in.)	
Avg. dressed wt.	48 g (1.7 oz.)	99 g (3.5 oz.)
Avg. wt. after cooking	33 g (1.2 oz.)	75 g (2.6 oz.)
Yield: Weight of cooked fish as percent of total wt.	37.5%	45.7%

Table 13.—Sensory evaluation of bone-softened shortbelly rockfish and jack mackerel. This table was provided by Harold Barnett, Utilization Research Division, Northwest and Alaska Fisheries Center, NMFS, Seattle, Wash.

Sample	Odor[1]	Flavor	Texture	Acceptability	Rancidity[2]
Rockfish (control)	4.8 ± 1.7[3] (4)	4.5 ± 1.8 (6)	4.8 ± 1.6 (4)	4.5 ± 1.5 (4)	3.0 ± 2.1 (5)
Rockfish (soaked)	5.6 ± 1.4 (4)	4.9 ± 1.4 (4)	4.8 ± 1.6 (4)	4.9 ± 1.4 (4)	2.8 ± 2.3 (7)
Mackerel (soaked)	3.5 ± 2.1 (6)	4.1 ± 2.3 (6)	4.7 ± 2.2 (6)	3.4 ± 2.0 (6)	5.1 ± 2.6 (7)

[1]Sensory scale (except for rancidity) 9 to 1, with 9 indicating excellent and 1 poor quality. A score of 3 indicates a product of unacceptable quality.
[2]Rancidity scale 1 to 9, with 1 indicating no rancidity, 5 slight and 9 strong rancidity.
[3]Each number represents the mean of seven or eight evaluations ± the standard deviation. Numbers in parentheses represent differences between the highest and lowest scores.

percent for shortbelly rockfish and jack mackerel, respectively[3].

Outside Evaluation

The following procedure was followed to provide samples of bone-softened fish for outside evaluation.

Shortbelly Rockfish Samples

Fish were obtained directly from a fisherman and kept on ice for 2 days prior to processing. Fish averaging 88 g total weight were headed and gutted and washed. Half of the fish were then soaked in a 1.5 percent salt solution overnight at 5°C. One liter of this solution was used for 1.2 kg of dressed fish. The cured fish were aligned and wrapped in aluminum foil, and cooked in an autoclave at 121°C and 15 p.s.i. for 40 minutes. The uncured fish were also cooked in the same manner. All samples were then drained, and frozen individually at −25°C (−13°F).

Jack Mackerel Samples

Fish were obtained from a wholesale fish company, so no details of catch or handling were available. They were processed shortly after purchase. Fish averaging 164 g total weight were headed and gutted and washed, then soaked in chilled 2 percent salt solution, with the addition of 0.25 percent sodium polyphosphate. Tea extract at a concentration of 0.25 percent was included in the soaking solution. The extract was prepared by steeping 2.5 g of crushed green tea leaves per liter of water at 100°C for 40 minutes. One liter of soaking solution was used for each 900 g of fish. The cured fish were aligned and wrapped in aluminum foil and cooked at 121°C and 15 p.s.i. for 30 minutes. The fish were then drained and frozen individually at −25°C.

Samples of bone-softened shortbelly rockfish and jack mackerel were shipped to the Utilization Research Division of the NMFS Northwest Alaska Fisheries Center, in Seattle. Before evaluation by a taste panel the samples were further treated by twice being dipped in batter and breaded. They were then deep-fried in vegetable oil from the frozen state at 190°C (375°F). Time required for cooking ranged from about 4 minutes for shortbelly rockfish to 7 minutes for jack mackerel. The cooked fish were served warm to an 8-member taste panel. The evaluation by the panel is summarized in Table 13.

Generally, individual panelists' reactions to both species were highly varied, but the average scores of both indicated a low to medium acceptance level. Shortbelly rockfish was judged to be better than jack mackerel in all respects, but this may have been due to high variability in the quality of the mackerel samples, some pieces of which were so rancid that one panelist declined to eat the product[4]. Shortbelly rockfish soaked in brine was preferred in all respects over those that were not soaked. Two panelists gave scores of 7 (= "good") in all of the sensory evaluation categories to soaked shortbelly rockfish. No hard bones were detected in either species by the panelists.

Discussion

Evidently many species of fish are amenable to a bone softening process. Among the groundfish and small pelagic species we tested, only the plainfin midshipman proved to have bones so hard as to be unsuited for the process. A secondary problem, emanation of objectionable odors, results from treatment at high temperatures. The odor, which is most pronounced in mackerels and sardines, probably needs to be reduced to increase acceptance of these species as bone-softened products.

The pelagic species have relatively large proportions of dark muscle, which contains higher levels of trimethylamine oxide (TMAO) as well as iron, than light muscle (Tokunaga, 1970). TMAO is broken down through cooking or bacterial action to trimethylamine (TMA), which is the source of most "fishy" odor (Tokunaga, 1975). Iron is a catalyst of thermal decomposition of TMAO to TMA. In Japan, green tea extract is commonly used to reduce this odor. The effective agents are the catechins, substances found in tea, which react with trimethylamine (Hata et al., 1980). Formation of disagreeable odors can also be decreased by using minimum times and temperatures when cooking fish in the autoclave. Thus, it is possible to manufacture satisfactory bone-softened products even with pelagic species which characteristically contain higher levels of TMAO.

In bone, insoluble calcium salts are supported by proteins and mucoids (nitrogen compounds), and the greater the calcium content, the harder the bone (Otani and Fujikawa, 1937). Bone softening by cooking is supposedly related to thermal decomposition of collagen, the main proteinacious component of

[3]Guide to underutilized species of California. Admin. Rep. T-83-01 (unpubl.) avail. at Tiburon Laboratory, Southwest Fisheries Center, 3150 Paradise Drive, Tiburon, CA 94920.

[4]Harold Barnett, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. East, Seattle, WA 98112. Personal commun.

bone, thus loosening the supporting texture. We expected that the minimum temperature necessary for softening bones of various species of fish might be correlated with the amount of calcium and collagen (or other nitrogen compounds) in the bone, but found no such relationship (Table 5). In fact of 11 species we studied, only the bones of the plainfin midshipman, and a rather large yellowfin tuna could not be easily softened, so this technique could be applied with many fishes.

In California, jack mackerel and Pacific mackerel are used mainly in canned form, for human consumption as well as cat food. A fair amount is also frozen for bait, and a small amount is sold as fresh fish. The average annual catch of these two species is high, compared with other California marine resources, amounting to over 50,000 tons annually. Thus these fish are good candidates for bone softening. Jack mackerel may be better suited for this process because it has firmer flesh with less red meat, however.

We find it particularly heartening that shortbelly rockfish makes an acceptable product, since this species is one of the most plentiful unused marine resources found off California. Although recent assessments of populations of shortbelly rockfish are not available, earlier works indicate that this species is abundant and easily caught in large numbers (Lenarz, 1980; Kato, 1981). Direct consumption of this fish is difficult because of the abundance of small bones and spines, and filleting is impractical because of the cost. Also, each fillet from mature individuals weighs only around 30 g (1 ounce), which is too small for most traditional methods of preparing rockfish.

Small, bony fish are not only inconvenient to eat, but their sharp bones and spines are also hazardous, especially to young children. Removing such bones before marketing is usually too costly, so most small fishes are not consumed directly. The introduction of bone-softening techniques around 1980 in Japan immediately made it possible to use a variety of small fishes and greatly increased the potential market for them. Because of its abundance, the Japanese sardine is the fish most used to make bone-softened products. A ready-to-fry breaded product is the most popular item. The bone-softening method used in Japan is essentially the same as that described here, but fish with coatings of various flavors are marketed, including curry, cream and parsley, and tomato. In addition, uncoated bone-softened fish are also sold. These are used directly in salads or other dishes applicable to canned tuna, or coated by the cook and fried. The composition of a breaded sardine product, with sesame seeds added for flavoring, is given in Table 14. Breaded fish are graded and packed in uniform size groups, around 25, 30, or 40 g per fish. At present, bone-softened fish is sold directly to institutional users only, and not in retail stores. The wholesale price in Japan for this product is about 25 yen per 25 g fish, or 1,000 yen/kg ($3.50/pound, at an exchange rate of 130 yen=$1.00). The price seems rather high when converted to U.S. dollars, but this is due to recent weakening of the dollar.

Table 14.—Proximate composition of Japanese commercial bone-softened breaded product made with sardine, *Sardinops melanostictus*, and percent composition of ingredients used to make the product. The data were provided by the manufacturer, Suzuhiro Co., Ltd., 245 Kazamatsuri, Odawara City, Kanagawa Prefecture, Japan.

Proximate composition of breaded product		Percent composition of ingredients	
Item	Comp.	Item	Comp.
Protein	17.6%	Bone-softened sardine	63%
Fat	8.2%	Breading	20%
Carbohydrate	9.0%	Wheat flour	5%
Ash	0.6%	Salt	1%
Calcium	338 mg/100 g	Sesame seeds	5%
Salt	700 mg/100 g		
Calories	183 KCal/100 g		

To learn how U.S. consumers might react to bone-softened fish products, we obtained from Japan samples of bone-softened and breaded sardine, *Sardinops melanostictus*, and filefish, *Thamnaconus modestus*. The samples were deep-fried in vegetable oil and presented to several staff members of the Tiburon Laboratory of NMFS. Nearly everyone who tasted the samples thought that the filefish, a mild, white-fleshed fish, was good in taste and texture when deep-fried. The oilier sardine, however, was thought to be too "fishy." The bones of both species were undetectable to all tasters.

Samples of filefish were next given to about 400 persons, most of whom were connected with the fishing industry. One sampling was conducted at a seafood and wine tasting event held at the Olde Port Inn, in Avila Beach, Calif., in February 1987. A second informal tasting was also done in February in Sacramento, Calif., in conjunction with the "Fishermen's Forum," which is conducted annually by state legislators. Most comments received from tasters were favorable, and the use of small fish, with bones intact, was thought to be an excellent idea both from the standpoint of fish utilization, as well as health aspects because of high calcium content. Most tasters also liked the flavor and texture of the product. Negative comments related mainly to the addition of calories by frying in oil. Practically no tasters were able to detect the presence of the softened bones and spines.

Recommendations

To knowledgably start commercial production of bone-softened products in the United States, several questions still need to be answered. The most important is to learn whether American consumers would purchase such products, and how much they would be willing to pay. We also need to learn which species are acceptable, and if costs associated with processing of those species allow commercial production. Research is also needed on ways to maintain quality of frozen bone-softened products and, especially, to lower or slow the onset of rancidity.

Should market studies be contemplated, we feel that satisfactory sample products can be made by using the procedures outlined in Figure 1. Types of coatings applied to bone-softened fish is a different area of research, but we feel that plain batter and breading is sufficient to allow representative test marketing of the product. Another way to obtain samples for test marketing may be to have a Japanese firm already manufacturing bone-softened products provide market samples made from

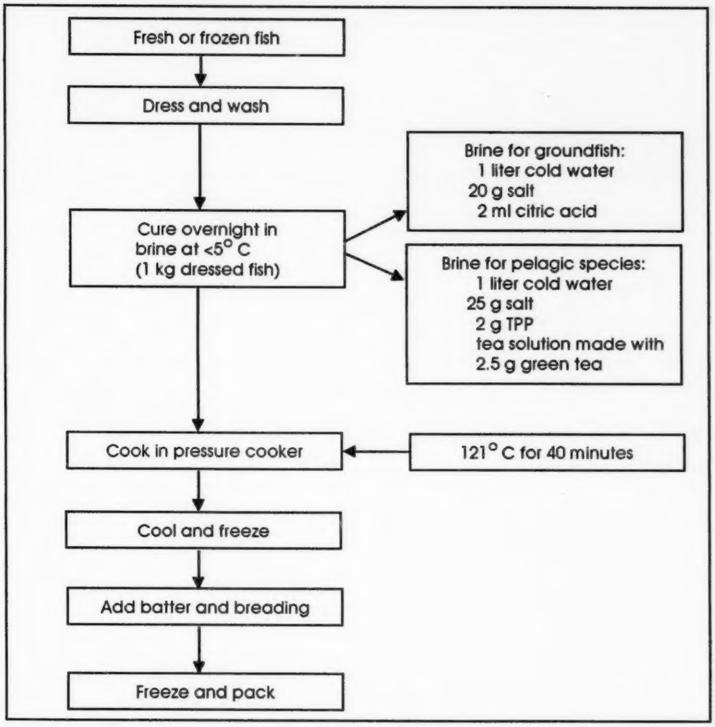

Figure 1.—Recommended procedures for making bone-softened groundfish and small pelagic species.

shortbelly rockfish and jack mackerel or other species with good potential (i.e., a large biomass). Processing costs may also be derived through such an arrangement.

Market research is needed to see if products other than deep-fried bone-softened fish are acceptable to the American consumer, who is becoming more and more conscious of calorie intake. Notwithstanding the questions remaining, we feel that bone softening is an effective means of utilizing species of fish that are too small for use in traditional forms, and we hope that this study will lead the way to eventual acceptance of this product form in the United States.

Acknowledgments

This study was funded by a Saltonstall-Kennedy Grant from the National Marine Fisheries Service to the West Coast Fisheries Development Foundation, Portland, Oreg., and to JAC Creative Foods of Los Angeles, Calif. Special thanks go to Sunee Sonu of the NMFS Southwest Regional Office who oversaw the project. We thank Robert Price of the University of California at Davis for reviewing the manuscript. We wish to thank the following for obtaining fish for this study: Giuseppe Pennisi of Royal Seafoods, Ken Morten of Lighthouse Seafoods, and Capt. Frank Donahue of the F/V *Gus D.* Barry Cohen of Olde Porte Seafoods and personnel of the Pacific Coast Federation of Fishermen's Associations allowed us to present samples of bone-softened fish at their receptions. Harold Barnett of the NMFS Northwest and Alaska Fisheries Center, Seattle, Wash., arranged the formal taste tests of the bone-softened products. Frank Kawana and Ted Suzuki made available space, personnel, and equipment resources of JAC Creative Foods and Yamasa Enterprises. Arthuro Martinez Aguilar and Antonio Villanueva Guitierrez of those firms aided in all phases of the experiments. Bert Yung of Pan Pacific Fisheries loaned us the autoclave used in this study.

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High-speed Heading and Gutting of Snipefish, *Macrorhamphosus gracilis*, an Underutilized Species

J. KNYSZEWSKI

Introduction

World fish consumption could be more than doubled if the presently underutilized or unused fishery resources were brought into the human food chain (Grantham, 1981). These resources, generally small pelagic species, remain unused not through lack of harvest technology but through the inability to transform them into stable and acceptable products and to distribute these products to consumers at a price they can afford.

Developments in minced fish technology could make a major contribution to increase exploitation. Minced fish is the flesh separated from the skin, bones, scales, heads, and viscera. The quality of fish mince depends not only on the raw material, but also on the nature of the separation process. Many methods have been applied to a wide range of mince products, although few are established commercially.

In a process described by Miyauchi and Steinberg (1970), the fish is beheaded, eviscerated, washed, and then passed through a machine that separates the edible muscle tissue from the skin, fins, and bones. These heading and eviscerating processes are extremely costly for small fish. Thus, most separation techniques are based on the whole fish by physically screening flesh from nonflesh components through a perforated filter. However, contamination by visceral material from ungutted fish can cause extensive proteolysis of the mince. Darkening of the mince can be caused by blood and head and gut contents. The viscera may also be associated with aesthetic aspects of taste and texture. Microbiological factors must also be considered when ungutted fish is used as a raw material (Grantham, 1981).

High-speed mechanized heading and gutting could solve these problems if the fish are properly oriented and arranged and fed automatically and speedily through the machinery. This study was designed to explore ways to orient and arrange uniformly an underutilized species, the snipefish, *Macrorhamphosus gracilis* (Fig. 1). We also sought to design, construct, and test a prototype of a commercial high-capacity heading and gutting machine for this species.

There are already some automatically fed heading and gutting or rodding or filleting machines developed by the Baader[1], Arenco, and Trio firms. Those process fish (i.e., herrings) over 20 cm in length, but their speed is only about 225 fish/minute maximum. A rodding machine used for Baltic sprats has a maximum capacity of about 1,100 fish/minute, but the fish are randomly oriented with the back uppermost, and the unit is not able to feed heading and gutting machines.

Materials

Snipefish, used in all experiments, inhabits the Portuguese and adjacent coasts (Brethes, 1979; Bakanev, 1985). Some surveys show it to be the most abundant species in Portuguese waters (IMR, 1978), and the entire catch (about 20,000 t/year) is converted to fish meal. The low harvesting level, at about 20

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[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

ABSTRACT—A process and scale-model machine have been developed for automatic heading and evisceration of the snipefish, Macrorhamphosus gracilis, *by utilizing its shape, abdominal cavity, structure, and skin texture (roughness). An arc or semicircular cut has been applied to heading and eviscerating. The parameters for a commercial prototype machine were also investigated and are discussed.*

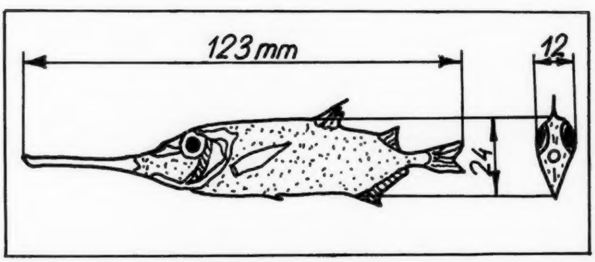


Figure 1.—The snipefish, *Macrorhamphosus gracilis*.

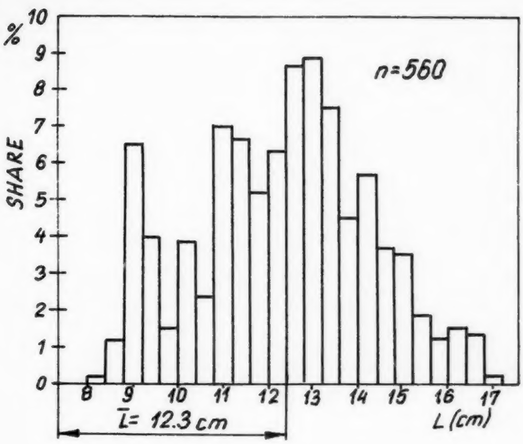


Figure 2.—Snipefish length distribution.

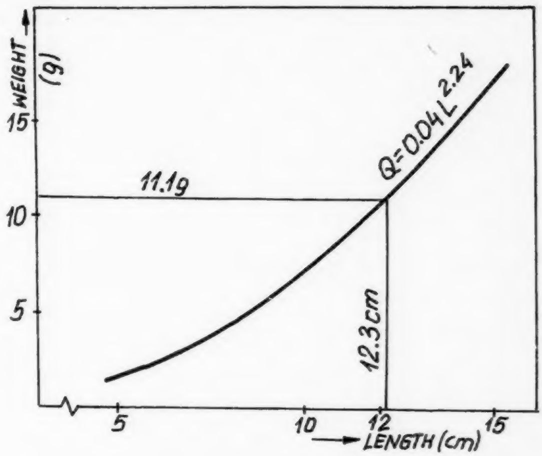


Figure 3.—Weight-length relationship of snipefish.

percent of capacity (Morais, 1981; Cadima, 1978; Santos and Moura, 1979), is mainly due to the lack of methods to process the species into acceptable products for human consumption.

Minced flesh from headed and gutted snipefish would appear to offer the best prospects for greater utilization. Calculations[2] made at the Instituto Nacionale de Investigacao das Pescas (INIP) in Lisbon suggested that an automatically fed heading and gutting machine capable of producing about 1,660 snipefish/minute (100,000 fish/hour) could assure economical operation.

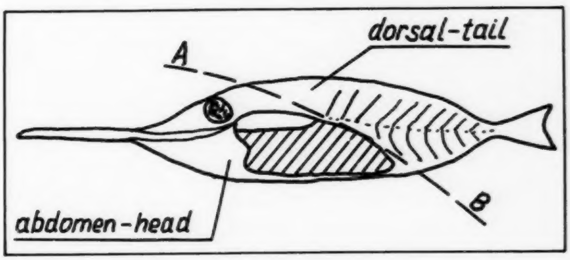


Figure 4.—Structure and site of abdominal cavity.

The mean length of the snipefish is about 123 mm (Fig. 1). Its body is extended, with a long rigid nose of about 30 percent of its total length. The average body depth is 24 mm, and the average thickness is 12 mm. Length distribution from two catches is presented in Figure 2, and the length-weight relationship is shown in Figure 3.

A survey of the snipefish body suggested an opportunity for devising a fast heading and gutting process. A longitudinal view (Fig. 4) shows the structure and position of the abdominal cavity, and along curve A-B it is possible to head and gut the fish with one arc cut. That divides the fish into two parts: The dorsal-tail (carcass) section with the most useful flesh portion, and the abdomen-head section. The dorsal-tail portion constitutes about 40 percent of the whole fish (by weight) and the abdomen-head portion is about 60 percent. The mean weight of snipefish is 11.1 g. Assuming a machine capacity of 100,000 fish/hour, the fish weight handled would be 1,110 kg/hour, producing 444 kg/hour of the dorsal-tail sections. This would give 266 kg/hour of pure deboned meat or flesh when a Baader B-694 separator is used. This was the basic assumption for our experimental work[3].

[2]L. C. Matos, Inst. Nac. Invest. Pescas, Lisboa. Unpubl. manuscr.

Experiments

Experiments were conducted in four steps or phases. In Phase I, an upper vibration table was developed to orient snipefish initially. In Phase II, intermediate and lower vibration tables were devised for final orientation of the fish. Phase III dealt with the heading and gutting apparatus, while Phase IV brought all the elements together into the complete machine.

[3]All experiments in this project were carried out by INIP, Lisbon. This research was supported in part by a grant of the Portuguese Government for 2 years and by a grant from Food and Agriculture Organization of the United Nations, as a Technical Cooperation Program, for 1 year.

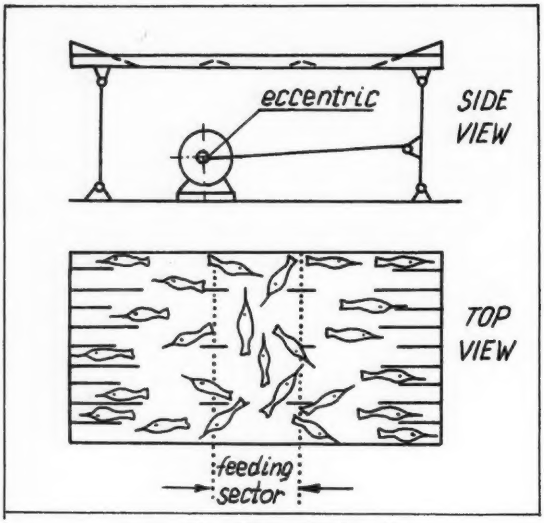


Figure 5A.—Upper vibration table.

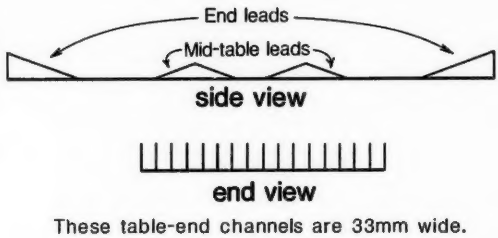


Figure 5B.—Leads and channels on upper table.

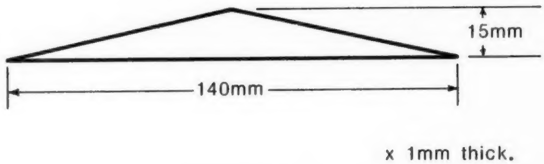
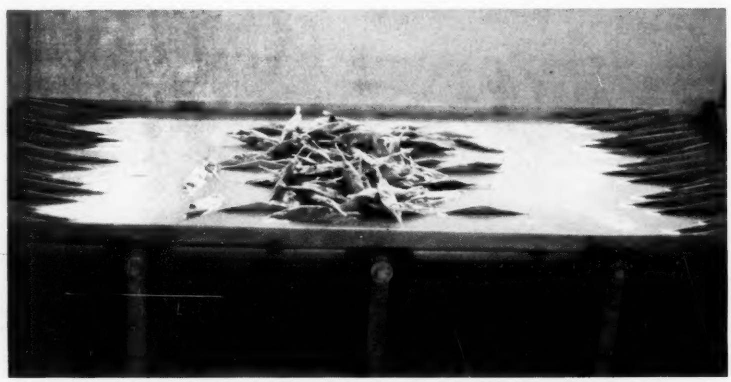


Figure 5C.—Dimensions of mid-table trangular leads.

Phase I

The principle of vibration was chosen to orient and propel the snipefish because of its proven effectiveness in the fish and agriculture industries (Carey et al., 1981). The model developed for the initial orientation—the upper table—is shown in Figure 5A. This vibration table is covered with a rough rubber layer and has 17-18 steel plate leads which form short channels at both ends (Fig. 5B). The plate leads are 10 mm high, 1 mm thick, and are 33 mm apart (Fig. 5B). It also has six thin triangular leads in mid-table (Fig. 5B, C).

The upper table is driven (via a connecting rod) by an infinitely variable-speed motor with an eccentric on its axle. The changeable eccentricity (eliptical orbit) was 1.0, 1.5, 2.0, 2.5, and 3.0 mm, producing table displacements of 4.0, 5.9, 7.9, 9.9, and 11.8 mm, respectively. The electric motor speeds were 400, 500, 600, 700, 800, 900, and 1,000 rpm.



The upper table with snipefish; note the end and mid-table triangular leads.

Snipefish were fed onto the central feeding sector of the upper vibration table (Fig. 5) in groups of 40-80 fish, repeated from 10 to 18 times. The textures of the table's rubber layer and the snipefish skin made it possible to orient and direct the fish nose-first toward both ends of the table. A slight sprinkling of water (about 2 gallons/hour) during experiments enhanced movement of fish toward the ends of the table (excessive water disturbed operations, however). The central triangular steel leads helped orient and direct the fish into the end channels. While samples of fish were fed onto the table, the effects of varied vibration frequencies and amplitudes were studied on the rate of snipefish reaching both ends of the table in proper orientation.

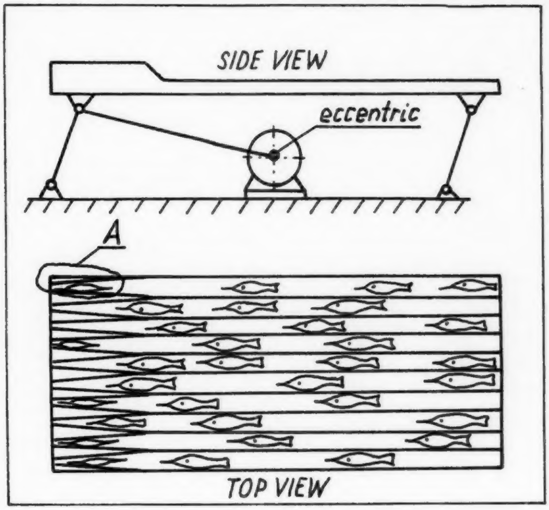


Figure 6.—Lower vibration table.

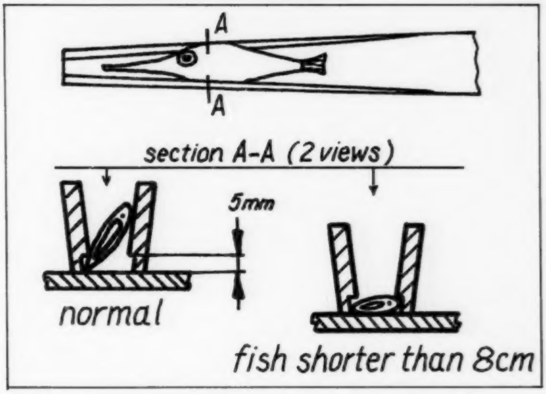


Figure 7.—Details of the channel "A", enlarged from Figure 6, top; below, proper and improper fish orientation.

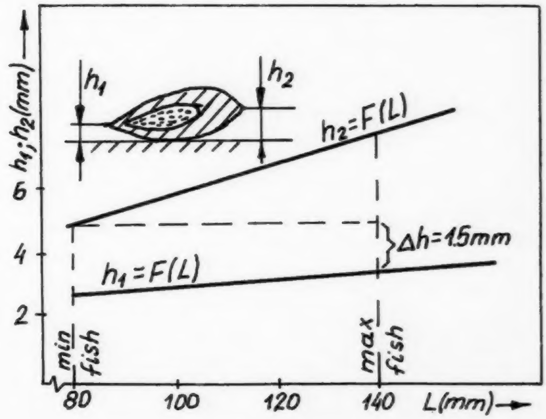


Figure 8.—The h_1 and h_2 values of snipefish of different sizes.

Phase II

The fish are discharged nose first from both ends of the upper table and lie at random on either their left or right sides on either an intermediate table or the lower table. The lower vibration table was designed (Fig. 6) to orient the fish and position them back uppermost and nose first. This unit consists of the vibration table, connecting rods inclined at 18°, an infinitely variable-speed electric motor with changeable eccentrics on its axle, a connecting arm, and channels for the fish on the table surface. Eccentricities were the same as in Phase I, but the table displacements were 2.0, 3.0, 4.0, 5.0, and 5.9 mm, respectively. There are two types of channels (Figs. 6 and 7) in the lower table. The first are the plate leads (as in the upper table) which lie along the table. The second type are the converging channels (30 mm high × 1 mm thick) at the end of the lower table which are to turn the fish so their back is uppermost (Fig. 7). (The intermediate table has 18 converging channels and receives fish directly from the upper table.) Two cavities at the base of all the convergent channels make it possible to turn each fish back uppermost because the snipefish, in cross-section, has different measurements (h_1 and h_2) as shown in Figure 8.

In practice, the fish, lying at random on their right and left sides, are fed into the channels at one end of the lower table. Vibrations propel the fish nose-first toward the convergent channels which then turn each fish back uppermost. While the fish moved along, the effectiveness of various vibration frequencies and amplitudes on turning of the fish was studied and measured by the rate of fish turned back uppermost at the end of the convergent channels.

Phase III

Here, we designed and constructed a scale model heading and gutting machine to test the arc cutting of properly oriented, positioned, and fastened fish. Snipefish placed precisely side by side, will lie in a circular position (Fig. 9). This fact allowed us to construct a rotating drum with individual plate rings to correspond with the channels in the intermediate and lower tables. These rings are provided with curved plates which receive and hold each fish (Fig.

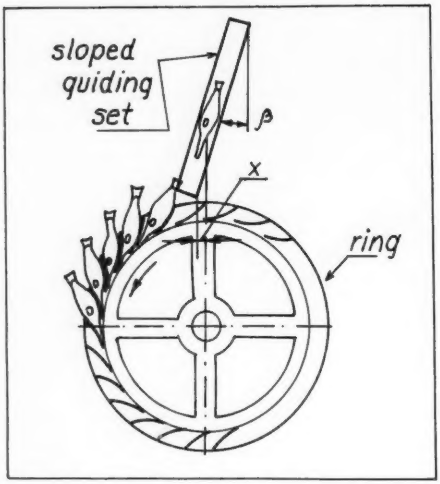


Figure 9.—Fish placed in position on one of the rings.

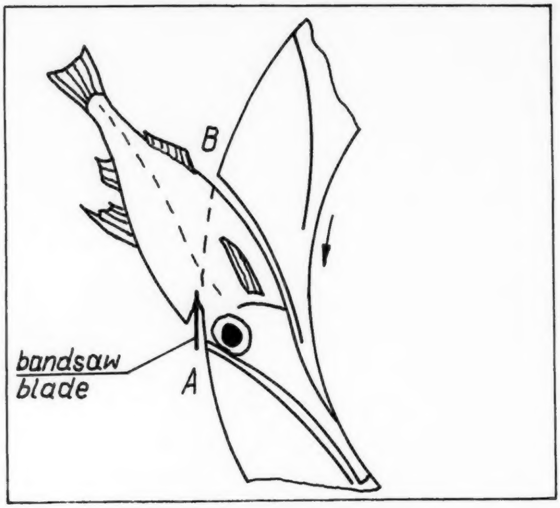


Figure 10.—Scheme of arc cutting.

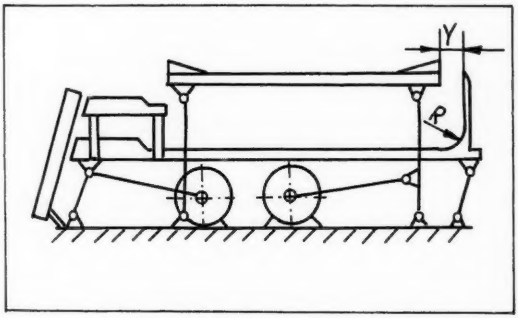


Figure 11.—Test stand showing upper and lower tables with guide (at right) to turn fish onto the lower table.

9). Each ring receives its fish from each convergent channels, via a sloped guiding set (Fig. 9). Altogether, our test machine had 35 channels and 35 corresponding rings on the rotating drum. And, each ring has 25 openings to receive the fish.

The inserted abdomen-head section of the snipefish is held inside the ring opening. A ring edge is approximately equal to the curve A-B (Fig. 4). To cut several fish at the same time, a bandsaw blade (knife) was installed close (0.5 mm) to the rings (Fig. 10). Then, while the drum revolves, the snipefishes in the ring openings reach the knife and the carcass is severed (Fig. 10).

Obviously, the fish must reach the ring openings. This depends on the proper distance to the drum axis and "beta" angle of the sloped guiding set as indicated in Figure 9. While the drum with rings rotated, the bandsaw blade speed and the fish samples were kept constant. The effect of distance "X" and the "beta" angle on the proper and effective positioning of the fish in the ring openings were studied.

Phase IV

After being oriented on the upper table, the fish are more or less separated in two streams, with one going toward intermediate table and the drum-ring apparatus. The other stream of fish must then be reversed so it also travels toward the heading and gutting elements, i.e., both streams of fish must feed through the sloped guiding set to the ring openings on the drum. To redirect the stream of fish toward the drum-ring apparatus, another scale model was constructed (Fig. 11). This consisted of the upper vibration table (where initial orientation takes place), the lower vibration table, an attached intermediate table, and a sloped guiding set where both streams of fish merge. At the end of the table opposite the sloped guiding set, a guide was attached to turn back that stream of fish. There, distance "Y" between the upper vibration table and the guide was measured (Fig. 11). The guide radius "R" had three measurements: 70, 80, and 90 mm. While the fish were discharged from the upper table, the effects of distance "Y" and radius "R" on turning the fish toward the sloped guiding set was studied, and success was measured by the share of fish properly turned back.

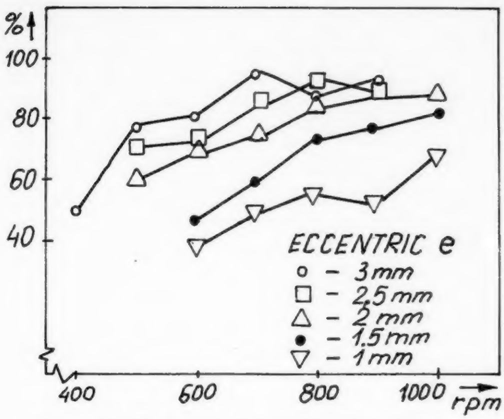


Figure 12.—Fish orientation results: Frequency vs. orientation effectiveness.

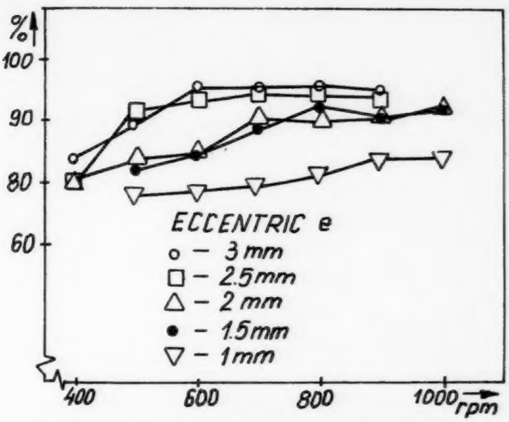


Figure 13.—Turning snipefish back uppermost in the converging channels: Frequency vs. turning effectiveness.

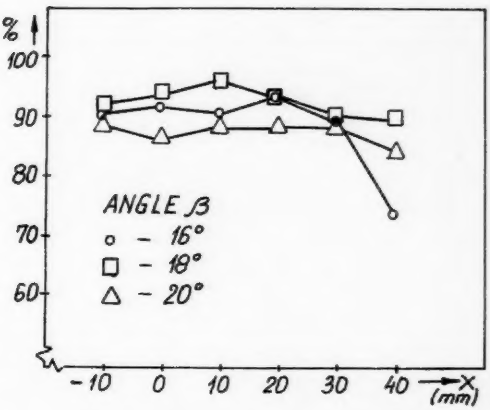


Figure 14.—Ring insertion accuracy: Beta angle and distance X (Fig. 9) vs. hitting effectiveness.

Results and Discussion

Phase I

About 93-97 percent of the fish placed on the central feeding sector of the upper vibration table turn nose-first and move toward either end of the table (Fig. 12) Some damaged fish (e.g., broken nose or pierced by another's nose) were subjected to different drag forces, at times in opposite directions. Fish with damaged belly cavities adhered to and stopped on the table. Fish travelling in opposite directions met and their movement tracks were disturbed.

The effectiveness of the orientation and movement depends also on the amplitude and frequency of vibrations. The greater the amplitude is, the lower the frequency is needed. Greater effectiveness was noted at larger amplitudes. When frequency increased above the optimum, interferences appeared and effectiveness gradually deteriorated. Excessive forces can cause fish movement paths to change which can sometimes induce fish circulation. And, when the amplitude is too great, the machine itself can be subjected to excessive mechanical forces and stresses.

Phase II

Traveling nose first on the lower table, the snipefish enter the channels where greater resistance to movement occurs. To keep the fish moving, greater vibration is induced with the connecting rods (Fig. 6). Generally, the greater the frequency and amplitude are, the greater is the vibration force; however, above the optimum level, fish movement becomes erratic, and sometimes they bounce, reducing the efficiency and speed of the process.

About 92-98 percent of the fish were properly oriented (Fig. 13). Fish >16 cm have a body depth greater than the channel width which prevented proper forward movement. And, fish <8 cm stopped in the converging channels because dimension h_2 was less than 5 mm (Fig. 8). Fish with full stomachs were more round in cross-section, like a mackerel, which caused them to be improperly oriented too.

Phase III

About 90-97 percent of the fish fed to the table at random were effectively oriented (Fig. 14) for an "X" distance of 10 mm and an 18° "beta" angle. Effectiveness gradually declined as the "X" distance increased or decreased. An increased "beta" angle caused the

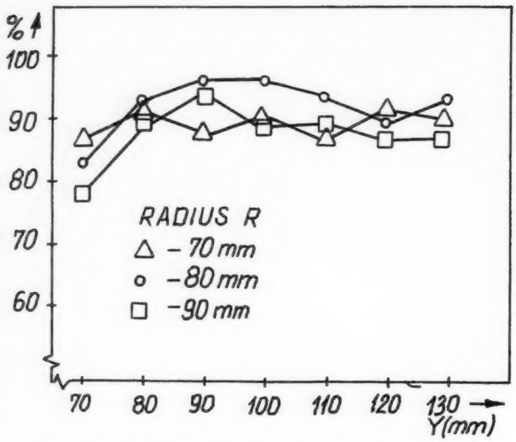


Figure 15.—Turning fish onto lower table: Distance Y (Fig. 11) vs. effectiveness.

fish to jump out of the ring openings. A decreased "beta" angle resulted in some problems with the fish reaching the openings and exiting the sloped guiding set.

Phase IV

During experiments to turn the fish onto the lower table (Fig. 11), a radius "R" of 80 mm was found most effective and a distance "Y" of 100 mm gave about 96 percent effectiveness (Fig. 15). If distance "Y" increases, it causes the fish to stop on the bottom of the guide. If distance "Y" is too narrow the fish nose catches on the top edge of the guide.

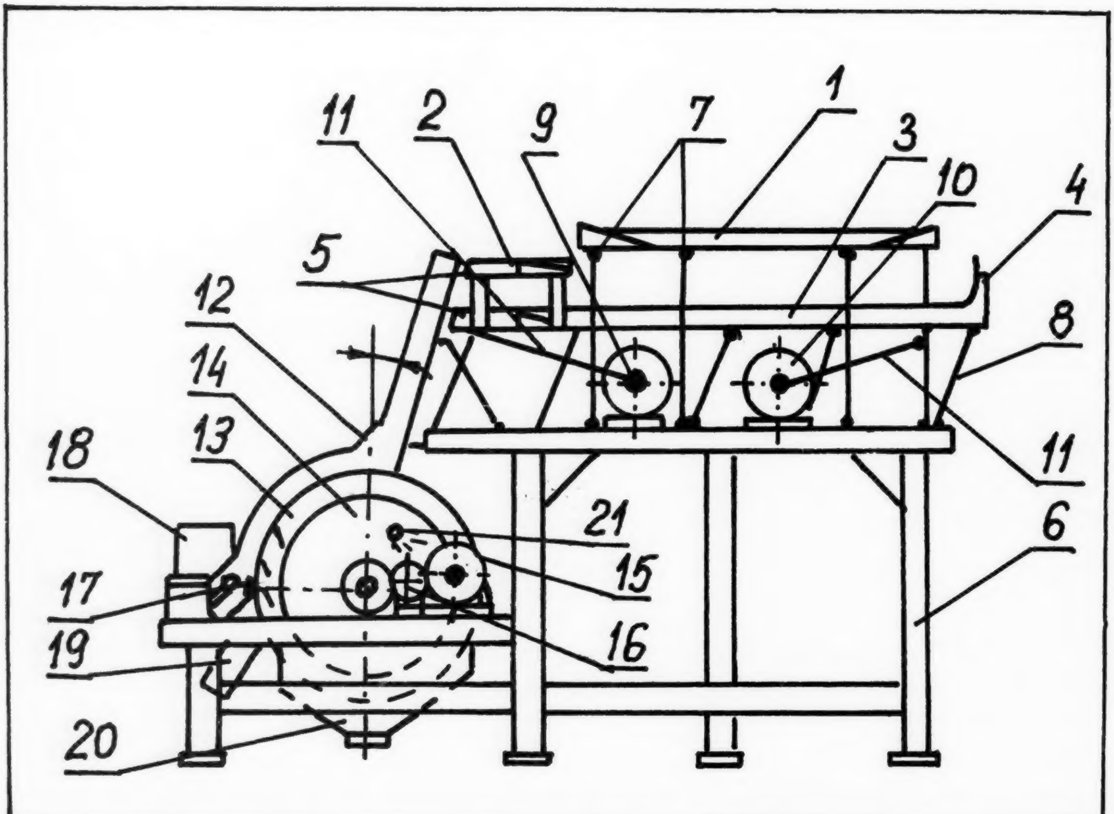


Figure 16.—Pictorial diagram of the entire machine. See text (page 15) for details.

Construction

A prototype of the snipefish processing machine was designed and constructed to meet the following considerations:

1) Capacity of about 1,800 fish/minute,
2) Cutting shape along curve A-B (Fig. 4),
3) Operating range for fish lengths from 8 to 15 cm,
4) Fish supplied by conveyor,
5) One-person operation.

The prototype machine (Fig. 16, 17[4]) operates as follows[5]: The fish are fed at a controlled rate at point A onto the upper vibration table (1)[6]. After orientation, the fish are discharged nose first onto an intermediate vibration table (2) from one side and onto the lower vibration table (3) from the other. A revolving guide (4) turns and directs the fish toward the converging channels (5) (18 above and 17 below) which turn the fish back uppermost. The vibration tables are attached to the machine frame (6) by the connecting rods (7 and 8). The tables are driven by electric motors (9 and 10) through the eccentrics and connecting arms (11). Finally, the fish are discharged from the converging channels of the intermediate and lower vibration tables into the sloped guiding set (12). The sloped guiding set feeds the fish into the openings of the rings (13) which are fixed on the drum (14). The drum is driven by an electric motor (15) through a reduction gear (16). While the drum revolves, the fish enter the openings and reach a bandsaw blade (17) where they are severed. The bandsaw is driven by an electric motor (18). Upon removal, the dorsal-tail sections exit (19) onto a shuttle while the abdomen-head sections drop through another opening (20). A flow of water (21) enhances cutting and removal of abdomen-head sections from the openings.

[4]The commercial prototype of the machine was constructed by Industrias Nacionas de Defesa E. P., Lisbon, and has been tested at INIP, Lisbon.
[5]Knyszewski, J. Polish patent appl. no. P. 245727.
[6]Numbers in parentheses correspond to the numbers on Figure 16.

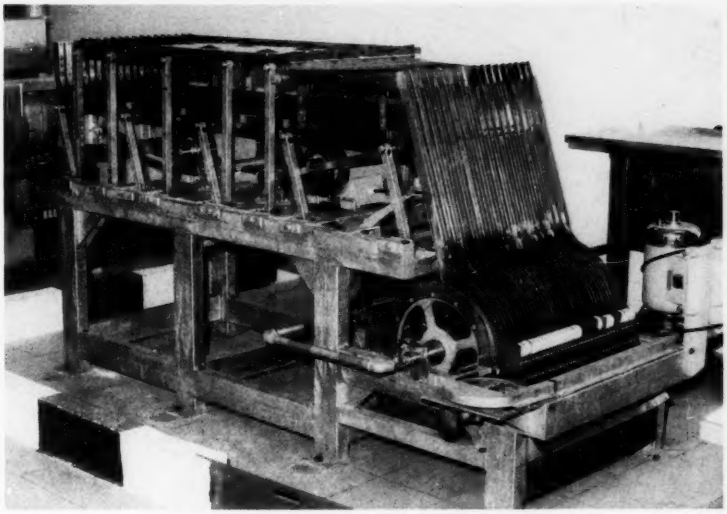


Figure 17.—The commercial prototype machine.

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The Status of Loggerhead, *Caretta caretta*; Kemp's Ridley, *Lepidochelys kempi*; and Green, *Chelonia mydas*, Sea Turtles in U.S. Waters

NANCY B. THOMPSON

Introduction

This paper provides an overview of the distribution, abundance, sources of mortality, and status of stocks for three species of sea turtles in U.S. waters from Maine to Texas. The species discussed include the loggerhead, *Caretta caretta*; green, *Chelonia mydas*; and Kemp's ridley, *Lepidochelys kempi*, turtles.

The loggerhead turtle is currently listed as threatened throughout its U.S. range. One of the world's largest aggregations of nesting females emerges on southeastern U.S. beaches from May to August every year.

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ABSTRACT—Available information on the ecology and status of stocks is summarized for the loggerhead, Caretta caretta, *the green* Chelonia mydas, *and the Kemp's ridley,* Lepidochelys kempi, *sea turtles found in U.S. waters. These species are listed as threatened, endangered in Florida waters, and endangered, respectively. The most conspicuous and abundant species is the loggerhead turtle which appears to have been relatively stable in numbers since 1982. The green turtle, which once supported a significant U.S. fishery, appears to be increasing in Florida. It is not known if this increase is from an expansion of range of Caribbean stocks or if there is a real increase in the number of turtles in the U.S. stock. The Kemp's ridley, which once nested in Mexico in the tens of thousands, has been reduced to a nesting population of less than 600 females. If the status quo remains, this species will be reduced to 100 nesting females within 60 years.*

The green turtle is listed as endangered in Florida and as threatened elsewhere in U.S. waters. The green turtle historically was the primary focus of U.S. turtle fishery activities.

The Kemp's ridley turtle is listed as endangered throughout its range and was so heavily exploited during the 1950's and 1960's in Mexico that the annual numbers of nesting females has dwindled from at least 47,000 in 1947 to less than 600 today.

Loggerhead Turtle

Distribution and Abundance

This species ranges from Maine to Texas, including the U.S. Caribbean Sea (Rebel, 1974). Seasonal migrations probably occur, with autumnal movements southward from primarily New York waters effectively contracting its range to waters of the southeastern U.S. and Gulf of Mexico in the winter. In the spring, turtles concentrate along the Florida east coast from Brevard to Palm Beach Counties. Results from aerial surveys have demonstrated that nonbreeding adults and immature turtles migrate occasionally as far north as the Gulf of Maine, and predictably as far north as Long Island, N.Y.[1] In the fall, turtles migrate to southeast U.S. waters and the Gulf of Mexico. Therefore, this species is ubiquitous waters from Maine to Texas in the U.S.

Aerial surveys conducted off the southeast U.S. coast from 1982 to 1984 by the National Marine Fisheries Service (NMFS) showed that turtles are distributed randomly from the coast out to the Gulf Stream except in the winter[2,3]. From North Carolina to Key West, Fla., the western boundary of the Gulf Stream approximates the 500 m bathymetric contour. During the winter, turtles appear to aggregate within the western Gulf Stream boundary waters which can be 5-6°C warmer than coastal waters[2,3].

Within the Gulf of Mexico, loggerhead turtles appear to be concentrated along the central-west coast of Florida. Sightings of turtles have been summarized from NMFS-sponsored aerial surveys in the Gulf of Mexico for Brownsville, Tex., to Key West, Fla. This survey program, supported by the NMFS Southeast Fisheries Center's Marine Mammal Program, is called GoMex. Surveys were completed independently from Brownsville, Tex., to New Orleans, La. (Northwestern Gulf, 4 seasonal surveys, 1983-84), and from New Orleans, La., to Key West, Fla. (Northeastern Gulf, 3 seasonal surveys, 1985-86). The ratio of loggerhead turtle sightings for the northwestern Gulf to northeastern Gulf was about 1:25. The area of turtle concentration along the Florida west coast is primarily within 139 km (75 n.mi.) of shore in

[1]CeTAP Final Report 1982. A characterization of marine mammals and turtles in the Mid- and North-Atlantic areas of the U.S. Outer Continental Shelf. Final Report of the Cetacean and Turtle Assessment Program, University of Rhode Island, Kingston. U.S. Dep. Int., Bur. Land Manage. contr. #AA551-CT8-48, 450 p.

[2]Thompson, T. J., and C. R. Shoop. 1982. Final report to the National Marine Fisheries Service. Contract No. NA82-GA-C-00012. Aero-Marine Surveys, Inc., Groton, Conn., 71 p.

[3]Powers, J. E. (editor) 1983. Report of the Southeast Fisheries Center Stock Assessment Workshop, Aug. 3-6, 1982. NOAA Tech. Memo. NMFS-SEFC-127. Miami, Fla. 229 p.

state and Federal waters and includes the Dry Tortugas shrimping grounds[4].

Three NMFS-sponsored aerial and ground survey projects to census nesting females resulted in estimates of nests and nesting females for 1980, 1982, and 1983 (Shoop et al., 1985; Powers[3], Murphy and Hopkins[5]). During this period, an annual average of 52,073 (±16,459, 95 percent C.I.) nests were excavated. These values are the best available estimates for the annual number of nests from North Carolina to Key Biscayne, Fla.

Loggerhead turtles also nest along the Florida west coast and sporadically along the entire Gulf of Mexico coast. However, it is not known how many turtles nest there annually. Those numbers cited are a minimum estimate. It is likely, however, that outside the North Carolina-Key Biscayne shoreline there are no more than an additional 1,000 nests, or 400 turtles (at 2.5 nests/female). Thus, at least 98 percent of all nesting occurs between North Carolina and Key Biscayne, with a known area of nesting concentration from Brevard to Palm Beach Counties.

Four aerial surveys have been completed over water to index marine turtle abundance. All were multispecies and only one program (funded by NMFS) was designed primarily to target marine turtles (called SeTS for Southeast Turtle Survey)[2,3]. During the SeTS program, nine seasonal surveys were completed in 1982-84 from Cape Hatteras, N.C., to Key West. The number of turtles within this study area has been estimated for each seasonal survey and includes a correction factor for turtles in the water column but not observable at the surface. This correction factor was provided by the NMFS Pascagoula Laboratory turtle remote sensing project[3]. Radio tags placed on turtles indicated that 2.3 minutes per hour or 3.8 percent of total time in the water was spent at the surface. The number of turtles sighted was significantly greater in the spring and summer than during fall and winter. The mean number of turtles present during the peak spring and summer survey, from North Carolina to Key West out to the Gulf Stream was 387,594 (±20,154, 95 percent C.I.). This estimate includes all animals of at least 60 cm carapace length (subadults and adults), and represents turtles at and below the surface.

Comparable surveys have been completed from North Carolina northward to Maine up to 370 km offshore[1]. These surveys were funded by the Minerals Management Service of the U.S. Department of the Interior from 1979 to 1981. These surveys targeted marine mammals; turtle sightings were secondary. Their estimates are minimal values and do not include turtles below the surface of the water. The number of loggerhead turtles at the surface peaked in the summer and the average summer estimate over a 3-year survey period (1979-81) was 7,702 (±1,748, 95 percent C.I.)[1].

In the Gulf, similar estimates can be made using the sighting/census data from the GoMex program. The total number of sightings of loggerheads for the Gulf was 1,428, and these sightings were made primarily off the west coast of Florida[4].

Mortality

Seven known sources of incidental mortality are: 1) Shrimping, 2) pound nets and fish traps, 3) gill nets, 4) longlining, 5) hook and line, 6) entrapment by power plants, and 7) enganglement in ghost gear and debris throughout their range.

Sea turtle catches by commercial shrimp trawlers have been examined by Henwood and Stuntz (1987). Data from three separate sampling programs were merged to estimate catch per unit of effort (CPUE), where catch is defined as numbers of turtles and effort as total hours of shrimp trawling standardized to 100 feet of headrope. CPUE was determined from data collected during: 1) 1979-81 by observers on shrimp vessels, 2) 1978-80 during experimental excluder trawl surveys, and 3) intermittent 1973-78 shrimp discard observations which included NMFS observers on shrimp boats reporting total discards, including turtles. These three programs accounted for 27,578 total hours of observed trawling effort throughout the Gulf and Atlantic from North Carolina to Texas. Total turtle catch was estimated by multiplying CPUE values with total shrimping effort. Total turtle catches by species for the southeast Atlantic and three Gulf subregions were estimated and total number of turtles killed were estimated using average mortality rates from these three programs. Mortality by region for loggerhead turtles showed that at least 72 percent of the total mortality occurs along the southeastern United States from South Carolina to Florida (Table 1; Henwood and Stuntz, 1987).

Table 1.—Estimated number of turtles killed, ±95% confidence intervals, by shrimping by region.

Species	Region	No. killed ±95% C.I.	Percent of total killed by species
Loggerhead	S.C. to Fla.	7,293±326	72
	W. Gulf	998±249	10
	N. Gulf	1,210±330	11
	E. Gulf	675±183	7
Green	S.C. to Fla.	133±44	40
	W. Gulf	50±50	16
	N. Gulf	109±109	36
	E. Gulf	15±15	5
Kemp's Ridley	S.C. to Fla.	368±74	39
	W. Gulf	249±150	22
	N. Gulf	165±110	22
	E. Gulf	59±29	7

An examination of turtle captures by region and season was completed. However, because sampling was nonrandom, these results most likely reflect observer coverage rather than turtle distribution and abundance. Of the total turtles sampled along the Texas coast, 36 percent were caught during the spring and summer. In the eastern Gulf, 92 percent were caught in the winter. Along the southeast Atlantic coast, 64 percent were caught during the summer from northern Florida to South Carolina. This area accounted for 95 percent of all east coast turtle catches from April to December. All winter caught turtles

[4]Thompson, N. B. 1986. A summary of marine turtle sightings from NMFS/SEFC aerial census surveys for cetaceans and turtles in the Gulf of Mexico. SEFC, Miami Laboratory, Unpublished report, 9 p.

[5]Murphy, T. M., and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, U.S. Final Report to NMFS/SEFC. Contract No. NA83-GA-C-00021. Miami, Fla. 59 p.

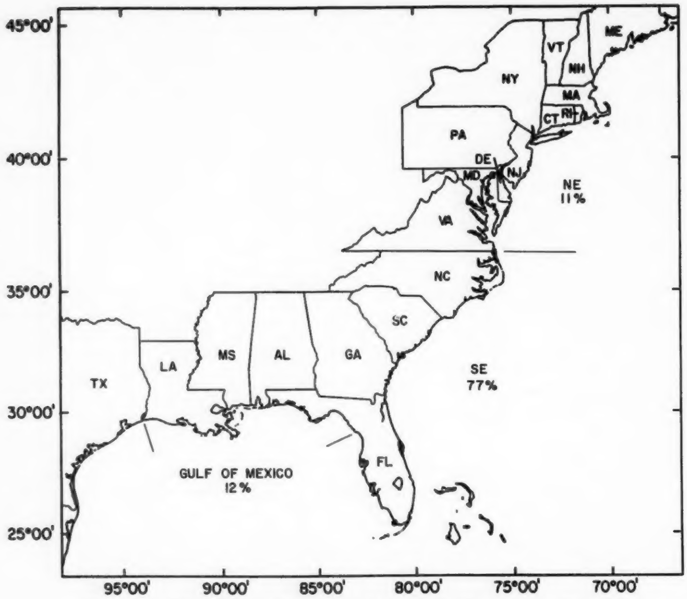

Figure 1.—Distribution of loggerhead turtle strandings reported by region along the Gulf of Mexico and Atlantic coasts. NE = Northeast; SE = Southeast; The relative proportion of total strandings are presented by region.

were reported from the Cape Canaveral area[6].

Mean depth of water when turtles were captured was 15.94 m (±13.92, 95 percent C.I.) for the Gulf and 9.43 m (±9.43, 95 percent C.I.) for the east coast. These capture depths represent where turtles were when caught and may not reflect the distribution of turtles by depth in the Gulf or off the east coast. In fact, from the SeTS aerial surveys, turtles were observed in water depths of 273 m.

The dependence of mortality (percent killed) on trawl tow time was examined using a least squares linear regression[6]. The percent mortality remains essentially zero through 60-minue tows, increases to about 10 percent at 90 minutes, and increases linearly to about 55 percent with 330-minute tows. Thus, it appears that mortality can be significantly minimized by restricting tow times to less than 90 minutes[6].

Loggerhead turtle mortality was estimated independently for the Atlantic. Published values of turtle catch per 1,000 pounds of shrimp landed were multiplied by annual shrimp landings[7]. The annual numbers of turtles killed ranged from 7,913 to 18,148. Published CPUE values (of turtle catch per 1,000 hours shrimp trawling) were expanded by the total shrimping effort to obtain estimates of annual turtle kill in the Gulf of Mexico yielding from 3,555 to 4,716 turtles killed annually. Adding these values yields an estimated annual turtle kill of between 11,468 and 22,864. These values are similar to those described previously. Thus, the best available information suggests that the annual estimate of turtles killed by commercial shrimpers ranges between 10,000 and and 23,000 since 1973.

Strandings on U.S. coasts from Texas to Maine are reported to the NMFS through the Sea Turtle Stranding and Salvage Network (STSSN). Causes of mortality are not always known, and reports are received opportunistically. Based on the voluntary nature of this network, it is assumed that all strandings are minimum estimates of mortality. Only animals that are dead or dying on the beach, in the surf, or in inshore waters are included in the STSSN numbers.

Three regions are defined as: Gulf of Mexico from the Texas/Mexico border to Key West, Fla.; Southeast U.S. (SE) from Key Largo, Fla. to the North Carolina-Virginia border; and the northeast U.S. (NE) from the North Carolina-Virginia border to Maine. Within the Gulf of Mexico, three subregions are defined: Western Gulf (WG), representing the entire Texas coast; the Northern Gulf (NG), Louisiana, Mississippi, Alabama, and the Florida Alabama border to Apalachicola, Fla.; and the Eastern Gulf (EG), Apalachicola, Fla., to Key West. Loggerhead turtles strand along the entire Gulf and Atlantic coasts throughout the year. Analysis of strandings was for 1980-83, and it showed 7,468 reported strandings for loggerhead, green, and Kemp's ridley turtles, of which almost 90 percent (6,691) were loggerhead turtles. By region, 77 percent (5,150) of total loggerhead strandings were reported in the SE, 12 percent along the Gulf coast, and 11 percent in the NE (Fig. 1). Thus, three times as many loggerhead turtles were reported from the SE as along the Gulf and NE coasts combined, which is consistent with the known distribution of loggerhead turtles as shown in aerial surveys. Within the Gulf of Mexico, the proportion of loggerhead turtles relative to total strandings was from 65 percent in the WG to 77 percent in the NG and 82 percent in the EG. These proportions are consistent with the known distributions of loggerheads as described previously.

Seasonal peaks in strandings occur in

[6]Henwood, T. A., and W. E. Stuntz. 1986. Analysis of sea turtle captures and mortalities aboard commercial shrimp trawling vessels. NMFS/SEFC, Pascagoula Laboratory, Pascagoula, Miss. Unpubl. rep., 56 p.

[7]Thompson, N. B., and J. E. Powers. 1987. An assessment of the status of the loggerhead turtle (*Caretta caretta*) in the U.S. Natl. Mar. Fish. Serv., Southeast Fish. Cent., Miami, Fla., manuscr.

all regions in the spring and summer. In the SE, almost 84 percent of all reported strandings occurred from April to August; in the NE, 79 percent were reported from April to July; in the NG, 68 percent were reported from April to August; in the WG, 79 percent were reported from April to August and in the EG, 70 percent were reported from March to June. Because these data are reported opportunistically and there is no way to stratify sampling effort, no inferences can be made as to the cause of this spring-summer seasonal peak in reports.

In March 1986, large numbers of turtles stranded along the Texas coast. During the same period offshore oil platforms had been removed from Federal and state waters. Removal requires the use of explosives to dismantle platforms. NMFS is continuing to monitor this situation to determine if there is a cause and effect between oil platform removal and turtle mortality (Klima et al., 1988). Information on the other listed sources of mortality is limited and sometimes anecdotal; however, there is a need to describe and quantify all potential sources of mortality.

Status of Stocks

The survivorship requirements of the southeast U.S. loggerhead population were examined, assuming that their abundance (about 387,000) represents the major reproductive component and can be considered a "unit stock."[7] Analyses were also conducted assuming that fishing mortality was between 10,000 and 23,000 turtles annually[6]. Between 0.8 percent and 5.2 percent of the hatchlings entering the water must survive to maintain this population as stable. These values are not contradicted by estimates from other populations of loggerheads and of other sea turtle species which average about 1 percent, i.e., 1 percent of hatchlings must survive to become breeding adults for the population to maintain stability.

Based on the best available information for the abundance of nesting females and number of turtles in the water, it appears that since 1980 this population has remained stable. However, because turtles cannot be aged, it cannot be determined when conditions resulted in stability, that is, whether this stability reflects conditions 5, 10, or 20 years ago is not known. No long time series is currently available for any population statistic; thus, it is impossible to develop quantitative assessments on the status of this stock relative to levels prior to the Endangered Species Act of 1973, or to make predictions as to what will happen to the population beyond the next 10 years[7].

For example, shrimp-related mortality may have negatively impacted this population in the 1970's while at the same time protection of nesting beaches improved egg and hatchling survivorship. The 1980's population estimate of 387,000 is a result of both of these factors. We do not have an adequate data base to evaluate these conflicting effects on the population dynamics of this stock.

The level of loggerhead abundance in the water during 1980-84 was stable and relatively large. Given current existing levels of mortality there is no apparent risk of major declines over the next 10 years. However, this population needs to be monitored regularly over the long term with continued full protection to detect changes in population levels and develop a predictive data base.

Green Turtle

Distribution and Abundance

Within the United States, green turtles currently nest along the Florida coast, Puerto Rico, and the U.S. Virgin Islands (Rebel, 1974). Florida east coast from Brevard to Broward Counties (roughly Cape Canaveral to Ft. Lauderdale). Historically the most significant nesting was on beaches of the Dry Tortugas, but this aggregation was extirpated by exploitation early in the 20th century. Currently, sporadic nesting continues to be observed as far north as North Carolina.

Historically, fisheries for this species were centered along the Texas coast and the Florida east and west coasts (Ehrhart, 1983; Hildebrand, 1981; Rebel 1974). Juveniles (<60 cm carapace length or CL) and a few subadults (60-90 cm CL) were captured primarily in nearshore waters and in local estuaries. Landings were reported from Port Aransas, Tex.; Cedar Key, Fla. (west coast), and along the Indian River, Fla. (east coast). Juveniles were also predictably captured during the summer in the bays and inlets along the North Carolina coast. Historically and presently it appears that the majority of green turtles in U.S. waters are immature (<60 cm CL). It is likely that at least some turtles arrive seasonally from the Caribbean and therefore this "population" cannot be treated as "closed." Thus, it is unlikely that all immature turtles in U.S. waters are products of U.S. nesting females, and the potential impact from any cause of mortality cannot be evaluated at this time.

There are no historical or current estimates of abundance for nesting turtles within the United States. Notably, the only significant nesting assemblage was reported on the Dry Tortugas. It was estimated that in the 1800's up to 2,800 females nested per year on the Dry Tortugas but this nesting population was extirpated through exploitation by the 1900's.

No current U.S. abundance estimate of nesting females is available. In fact, there is only one index of nesting activity which is for a very restricted area within Brevard County, Fla., where it has been estimated that about 40 females nest annually. It is likely that nesting occurs on the many Florida keys, cays, and elsewhere along the Florida east coast. The minimum annual estimate is a "best guess" and is about 300 females.

Very limited information is available for the species in the water. However, it is known that the majority of turtles within U.S. waters are immature. Historically, within the Indian River system on the Florida east coast the maximum green turtle catch was reported as 2,500 turtles in 1886. By 1895, the annual turtle catch was about 500 animals or a decrease of 80 percent from the 1886 level. This decrease is attributed to fishery activities and on unusually cold water in 1894-95, which ultimately caused the collapse of this fishery (Ehrhart, 1983).

Fishery activities resumed in this area around 1970 and increased from 1,625

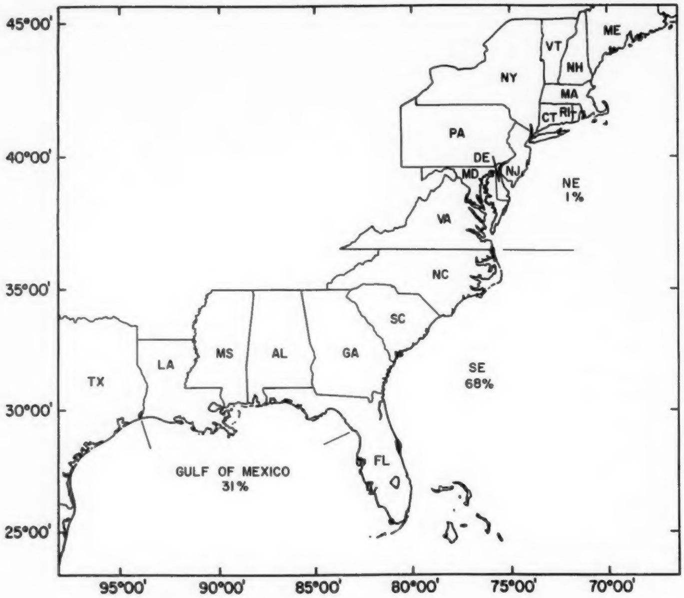

Figure 2.—Distribution of green turtle mortality by region along the Atlantic and Gulf coasts. The relative proportion of total strandings are presented by region.

kg landed in 1970 to 4,152 kg landed in 1974. Using the historical average weight per turtle caught of about 8 kg yields turtle catch values of 203 for 1970 to 519 for 1974. It is currently estimated that about 1,500 green turtles utilize this area (Ehrhart, 1983). Thus, within this restricted area, the number of turtles observed appears to be increasing since at least 1980.

Mortality

Turtles have been reported dead from the following sources: 1) Gillnet fisheries, 2) power plant entrapment, 3) hook and line fishing, 4) possibly from offshore oil platform removal by explosion, 5) shrimp fishing, 6) entanglement in ghost fishing gear and debris and 7) ingestion of debris.

The numbers of turtles that are caught or die from sources 1-4 are unknown. Shrimp fishing mortalities have been estimated for green turtles by NMFS and for loggerhead turtles (Table 1; Henwood and Stuntz, 1987). The total estimated number of green turtles killed represents about 3 percent of the total estimated number of loggerhead, green, and Kemp's ridley turtles killed. Notably, 36 percent of the total estimated mortality occurred in the northern Gulf, which includes Louisiana, Mississippi, Alabama, and the Florida panhandle. These turtles were immature and probably in transit to the Florida west coast. Green turtles in the northern Gulf may be in the omnivorous feeding stage (up to 3 years) and migrate to the west coast of Florida upon reaching the herbivorous stage. Thus, it appears that only the immature, omnivorous stage turtles are vulnerable to trawl capture which may impact recruitment into breeding populations. All turtles were caught in waters of less than 20 m depth. The mean water depth of capture in the Gulf and off the east coast was about 10 m.

A total of 317 green turtle reports are maintained in the STSSN data base representing about 4 percent of the total records which is consistent with the proportional representation of green turtles killed by shrimping. Of these, 97 (31 percent) were reported from the Gulf; 214 (68 percent) from the southeast and 6 (1 percent) from the northeast (Fig. 2).

Seasonal peaks for reported strandings are variable by region. In the western Gulf, the peaks in strandings occurred in the summer and late fall-early winter. In the southeast, there was a peak from October to January. In the northeast, strandings were only reported in September, November, and December. This species is considered subtropical and tropical in range. However, it is likely that expansion or contraction in range is associated with seasonal changes in water temperature. The occurrence of green turtles north of Virginia is considered unusual at any time of year.

Status of Stocks

There are no consistent current indices of abundance for this species within U.S. waters. The proportional representation of green turtles from the STSSN and from the estimated total number of turtles killed by shrimping are similar at 4 percent and 3 percent, respectively. If green turtles represent 3-4 percent of total turtle numbers in the southeastern United States, or 3-4 percent of loggerhead numbers, then there are about 600-800 nesting females from May to August or about 11,000-16,000 total turtles within the southeastern United States throughout the year.

If the increase in the number of females nesting on continental U.S. beaches and the increase in the numbers of nonadult turtles within the Indian River complex are real and not simply a result of improved sampling, then it appears that this population has been slowly increasing since at least 1980. Historical estimates are unavailable, but must have been considerable since several commercial fisheries for this species existed in the Gulf, Florida, and Caribbean were supported for several decades. A restricted segment of the "population" appears to be vulnerable to shrimp trawl mortality. Yet this species appears to be increasing in U.S. waters which suggests that existing and potential international conservation ef-

forts may result in the recovery of this species throughout its U.S. and Caribbean range.

Turtle mortality by shrimping has been estimated as about 307 (±218) per year. Because green turtles are known long-distance migrants, and no regional abundance estimates are available for the species throughout the southeastern United States, Gulf, and Caribbean, the impact of any fishing mortality on this species cannot be determined. The similarity in proportional representation of green turtles killed as reported to the STSSN data base suggests that shrimpers catch and kill turtles at a level which directly reflects their proportional contribution to the total number of sea turtles in the southeastern United States.

The relatively small numbers of green turtles present in the United States and the rapidity with which they were depleted in the 1880's suggests that the current protective management regime is still needed to promote recovery of this species. If the number of females nesting on U.S. beaches and the number of turtles in the Indian River provide adequate population indices, then it appears that this "population" has been increasing at least since about 1980. To manage this species properly within U.S. waters requires an answer to the questions of whether turtles nesting on U.S. beaches are residents or transients and whether juvenile turtles in U.S. waters are products of these females.

Kemp's Ridley Turtle

Distribution and Abundance

The Kemp's ridley turtle is found from the Atlantic coast of South America throughout the Gulf of Mexico to New England. Their primary concentration appears to be within the Gulf of Mexico, and nesting is known primarily along 17 km of Mexican Gulf beach identified as "Rancho Nuevo" (Fig. 3), the name of a nearby fishing village (Marquez et al., 1981; Rebel, 1974).

Kemp's ridley turtles feed primarily on portunid crabs (e.g., blue crabs) and as a result concentrate in coastal waters of less than 100 m depth, which is why they are predictably observed in bays, sounds, and estuaries. While most turtles may spend their entire lives within the Gulf of Mexico, there are some which leave the Gulf probably via the Florida Straits and forage as far north as the Gulf of Maine during summer months, returning to Florida waters during the fall and winter. Whether these animals are ever recruited into the breeding population is not known. However, NMFS considers these turtles as potential recruits into the breeding population and therefore deserving of complete protection.

The only estimate of abundance available for this species are annual estimates of nesting females. This species is an aggregate nester (forming so-called "arribadas") which nests during the day along Rancho Nuevo beaches from May to August. Very little nesting is known to occur outside of Rancho Nuevo, and thus the Rancho Nuevo population is treated as a closed population. Beach surveys have concentrated on counting nests since 1978 and using a value of 1.3 nests per female per year (Marquez, et al., 1981) provides one way to estimate the annual number of nesting females (n) for years 1978 to 1987 as:

Year	*n*	*Year*	*n*
1978	642	1984	614
1980	636	1985	521
1981	690	1986	572
1982	577	1987	567
1983	574		

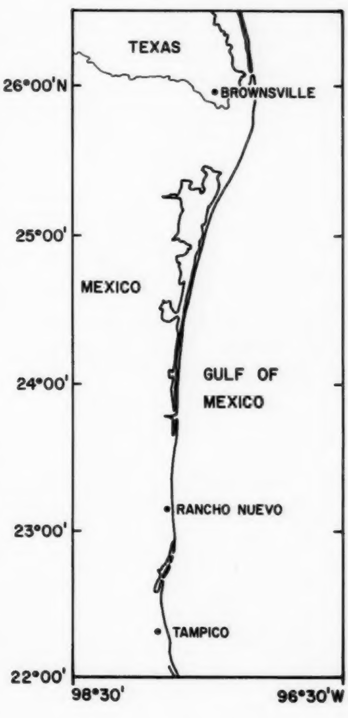

Figure 3.—Rancho Nuevo, Mexico, which is the focus of Kemp's ridley turtle nesting.

The annual average number of females nesting from 1978 to 1987 was 613 (±122, 95 percent C.I.). The largest estimate (734) was calculated for 1979 and the lowest for 1985 (521). Applying a simple linear regression to the natural log of numbers of nesting females vs. year shows a statistically significant ($P < .05$) decrease in number of nesting females of 3 percent per year. Recovery of this population to the only available historical annual estimate of 47,000 (from 1947) depends upon the rate of recruitment into the breeding population. At this time the annual recruitment appears to be less than annual mortality as demonstrated by the annual decrease in numbers of nesting females.

There are no estimates available for the numbers of nonnesting turtles throughout its range. However, it appears that the distribution of Kemp's ridley is very similar to the distribution of shrimping effort in the southeastern United States.

Mortality

A few records have been received by the STSSN indicating the following sources of incidental capture and death: 1) Pound nets (Virginia to Massachusetts, 2) fish traps (northeastern United States), 3) gill nets (sturgeon fishery, S.C.), 4) hook and line (surf fishing, Tex.), 5) power plant entrapment (southeast and northeast), 6) shrimping, and 7) entanglement in ghost fishing gear and debris and ingestion of debris.

A total of 460 Kemp's ridley turtle strandings have been archived in the SEFC/STSSN. By region, 49 percent

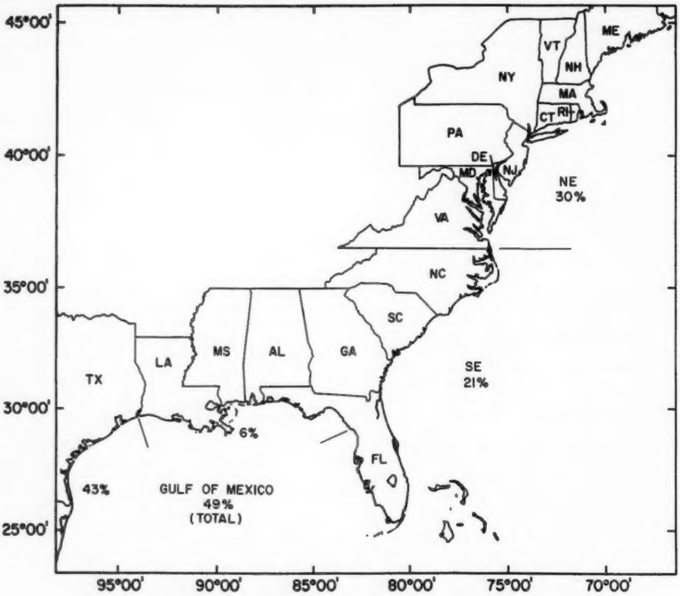

Figure 4.—Distribution of Kemp's ridley turtle strandings reported by region along the Gulf of Mexico and Atlantic coasts. The relative proportion of total strandings are presented by region.

were reported from the Gulf; 43 percent were reported only from the Texas coast; 30 percent were reported from the Northeast, primarily Virginia, New York, and Massachusetts, and 21 percent from North Carolina to the Florida east coast (Fig. 4). Within the southeast United States, 16 percent were reported from the western Gulf, 36 percent from the northern Gulf, and 5 percent from the eastern Gulf, and 43 percent from North Carolina to the Florida east coast.

Seasonal peaks in reported strandings by region were determined to be: April through November along Texas accounting for 93 percent of all Gulf strandings; and, November and December from the northeast Gulf and southeast Gulf. This late autumn peak in the northeast Gulf probably reflects turtle mortality resulting from "cold-stunning" or death from exposure to decreasing water temperatures. There were too few records in the remaining Gulf areas to discern any trends.

Estimates of CPUE were used to calculate the numbers of turtles killed by shrimping on a regional basis (Table 1). The total estimated catch in the southeastern United States, 1,409 (±282), was similar to that estimated for the Gulf, 1,726 (±863). All estimated CPUE values are one order of magnitude less than for loggerhead turtles, and thus loggerhead turtles are caught at least 10 times more frequently than Kemp's ridleys.

Mean water depth of capture in the Gulf and the Atlantic was 7.3 m (±4.82 m, 95 percent C.I.). While data collected by NMFS observers result in extremely precise estimates of mortality and provide insight into turtle distributions, they cannot alone be used to estimate numbers of turtles in the water. These data reflect the distribution of shrimping coincidental to turtle distributions. To sample for turtles requires sampling beyond shrimping grounds.

Total estimated numbers of Kemp's ridleys killed by shrimping are about equal for the Gulf and southeastern U.S. However, reported strandings were not evenly distributed between these two regions, with 43 percent reported from Texas alone. Thus, it is unlikely that all Kemp's strandings resulted from shrimping mortality. However, there is no way to partition mortality into fishing or natural.

Status of Stocks

The only index available to evaluate this species is the number of females nesting annually at Rancho Nuevo, Mexico. It appears that this value has decreased at an annual average of about 3 percent since 1978. The current average annual nesting population of 624 is about 1.3 percent of the minimum estimate of 47,000 reported in 1947 (Hildebrand, 1981). Depletion of this stock resulted from harvesting eggs and nesting females on the nesting beach from the 1950's to the early 1970's. Under the current regime of 3 percent loss of nesting females per year, it will take about 208 years for this nesting population to become extinct and about 59 years for it to be reduced to 100. However, with the number of nesting females currently less than 600, it is likely that extinction could occur sooner than predicted from the annual rate of loss of nesting females due to unpredictable environmental effects.

Marquez et al. (1981) presented an analysis showing an increase of 6 percent per year in numbers of nesting females using mark-recapture data collected since 1978. That is, they estimated annual recruitment into the nesting population as 6 percent based on the assumption that females arriving at Rancho Nuevo without tags were newly "recruited" into the nesting population. Thus, they assume no tag loss. There is no alternative evidence that recruitment has been enhanced. To the contrary, annual numbers of nesting females have been decreasing since 1978. Thus, if the current conditions remain, this nesting population will continue to decrease.

Conclusion

Of the three species discussed, loggerheads comprise about 90 percent of the total turtle numbers from Texas to

Maine. The Kemp's ridley turtle may represent as much as 6 percent, with green turtles comprising about 4 percent of the total turtle biomass. These relative proportions are represented within reported strandings and by the composition of turtles killed by commercial shrimping. However, discrepancies in the regional distributions of turtles killed by shrimping and turtles washing ashore dead indicate that reported strandings do not always reflect shrimp-related mortality. This is particularly true for the Kemp's ridley turtle which annually strands along the northeastern U.S. coast in significant numbers during the late autumn. Cause of mortality is rarely definitively identified from stranded turtles and the proportion of dead turtles washing ashore in the southeastern United States which result from shrimping cannot be determined. To evaluate turtle mortality resulting from shrimping or turtle mortality associated with any fishery activity, on-board observation provides the most precise data. This was shown as a result of the surveys conducted by the SEFC's Pascagoula Laboratory (Henwood and Stuntz, 1987).

The best available information for loggerhead, green, and Kemp's ridley turtles was evaluated on a regional basis. The population of loggerhead turtles from Texas to Maine appears to have been stable since 1980. Green turtles may be slowly increasing in numbers in specific areas, but no information is available on numerical abundance throughout its range from Texas to Florida. At the current rate of decrease of 3 percent per year for nesting Kemp's ridley turtles it is predicted that there will be 100 turtles nesting by the year 2196.

Acknowledgments

Both Terry Henwood and Warren Stuntz of the SEFC Pascagoula Laboratory contributed significantly to the original manuscript. Larry Ogren, SEFC Panama City Laboratory, continues to share his vast knowledge of marine turtle ecology to my benefit. Stranding data were summarized by Barbara Schroeder, STSSN Program Coordinator, SEFC Miami Laboratory. David Senn produced the figures. Joseph Powers critically reviewed the manuscript, for which I am grateful.

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Kemp's Ridley, *Lepidochelys kempi*, Sea Turtle Head Start Tag Recoveries: Distribution, Habitat, and Method of Recovery

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Introduction

The Kemp's ridley, *Lepidochelys kempi*, is the most endangered of all sea turtles. The only known primary nesting site for this species is a 20 km (12.4-mile) stretch of beach at Rancho Nuevo, Tamaulipas, Mex., located about 322 km (200 miles) south of Brownsville, Tex. (Hildebrand, 1963). An estimated 40,000 Kemp's ridleys nested near Rancho Nuevo in 1 day in June 1947 (Carr, 1963; Hildebrand, 1963); no more than 600 females nested there during the entire 1987 season[1].

In 1977 the Instituto Nacional de la Pesca (INP) of Mexico, the U.S. Fish and Wildlife Service (FWS), the National Park Service (NPS), the National Marine Fisheries Service (NMFS), and the Texas Parks and Wildlife Department (TPWD) agreed on a conservation program designed to save the Kemp's ridley. The purpose of the program is to increase the wild population of Kemp's ridleys through protection of the nesting beach and an experimental project to establish a second nesting site at Padre Island, near Corpus Christi, Tex., through head starting (Klima and McVey, 1982). The goals of the head start research project are to:

1) Rear Kemp's ridley hatchlings in captivity for about 1 year,
2) Tag and release healthy survivors,
3) Determine distribution and movement of released turtles, and
4) Document nestings of head-started turtles on Padre Island or elsewhere (Fontaine et al., 1985).

To try to create a second nesting site at Padre Island, the hatchlings are "imprinted" (Carr, 1967) to Padre Island sand in hopes they will return there to nest when they reach maturity. Each season INP and FWS transfer about 2,000 eggs from Mexico to the United States for the head start project. The eggs are collected in plastic bags as they are laid, to prevent them from touching the Rancho Nuevo sand, and are placed into polystyrene foam boxes containing sand from Padre Island National Seashore. The boxes of eggs are taken by plane from Mexico to the NPS at the National Seashore, where they are incubated and hatched. The hatchlings are allowed to crawl over the sand and swim briefly in the surf, to complete the "imprinting" process, before being captured and taken to the Sea Turtle Head Start Research Facilities at the NMFS Southeast Fisheries Center's Galveston Laboratory, Galveston, Tex.

This paper summarizes tag recoveries of head started Kemp's ridleys from year classes 1978-86, during the period February 1979 through December 1987, and it represents an update of Fontaine et al (In press b). Tag recoveries are summarized by year class, distribution, method of tag recovery, habitat, turtle status (live or dead), and season. Some interesting multiple tag recoveries are presented, along with a discussion of why Kemp's ridleys, especially juveniles, are commonly found in bays and shallow coastal areas.

Methods

Headstarting

Fontaine et al. (In press a) described facilities, care, and maintenance of head started turtles and tagging and release procedures. All data in this summary

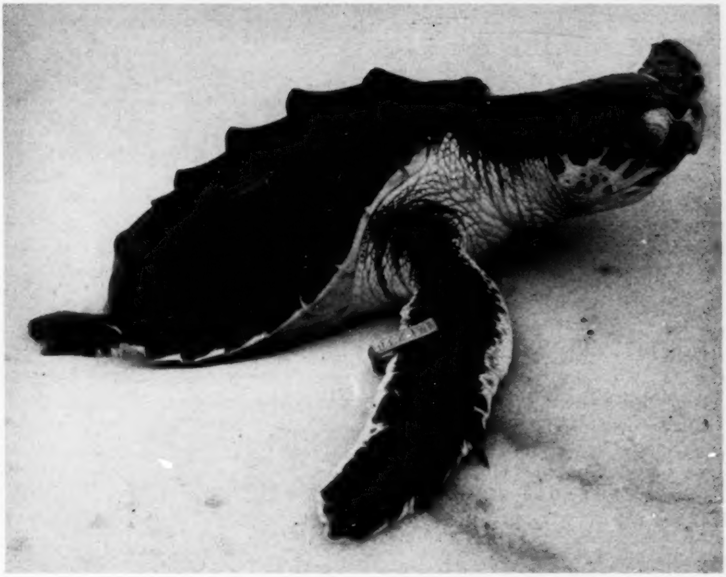
[1]Jack Woody, U.S. Fish and Wildlife Service, P.O. Box 1306, Albuquerque, NM 87105. Personal commun., Sept. 1987.

The authors are with the Galveston Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, 4700 Avenue U, Galveston, TX 77551-5997.

ABSTRACT—The Kemp's ridley sea turtle, Lepidochelys kempi, *head start research project is an international conservation effort to increase the wild population of Kemp's ridleys and to create a second nesting beach on Padre Island, Tex. Turtles are reared in captivity for about 10 months, tagged, and released at various locations in the Gulf of Mexico, but primarily off Padre Island. Tag recoveries are summarized by distribution, method of recovery, habitat, and season.*

A total of 12,422 turtles from nine year-classes (1978-86) of Kemp's ridleys have been released since the project began in 1978. As of 31 December 1987, 547 (4.4 percent) tag recoveries have been reported. Tag recovery data show turtles were reported from Mexico, all of the Gulf Coast states and most of the states on the U.S. east coast as far north as New York. A few tag recoveries were reported from France and Morocco. Primary recovery locations are Texas (60.9 percent), Louisiana (14.0 percent), and Florida (10.3 percent), and primary tag recovery methods include strandings (34.3 percent) and shrimp trawls (27.6 percent). Tag recovery habitat data show that occurrence in bay waters or ocean waters is about equal with 45.8 and 31.8 percent, respectively. Kemp's ridleys probably move into bays and shallow coastal areas to feed. Seasonally, 52.5 percent of the tag recoveries occur during April, May, and June.

Figure 1a.—Flipper tag attached to the trailing edge of the right front flipper of a head-started Kemp's ridley sea turtle.



represent the recoveries of turtles with flipper tags (Fig. 1a, b). Flipper tag series for each year class are shown in Table 1. The majority of head started turtles were released during the spring in the Gulf of Mexico 19-32 km (12-20 miles) off Padre and Mustang Islands, Tex. (Table 1). There were releases in two Texas bays, Nueces Bay and Copano Bay, and one in Campeche Bay, Mex. Most of the 1978 and 1979 year classes were released 10-19 km (6-12 miles) off Sandy Key, East Cape, and Homosassa, Fla. (Klima and McVey, 1982).

Table 1.—Summary of head-started Kemp's ridley sea turtle release sites, numbers of turtles released, and flipper tag series used for 1978-86 year classes.

Year class	Release site	Release date	No. released	Tag series[1]
1978	Sandy Key, Fla.	22 Feb. 1979	307	G—
	East Cape, Fla.	through	219	F—
	Homosassa, Fla.	7 July 1979	1,380	
	Padre Island, Tex.		113	
1979	Homosassa, Fla.	3-5 June 1980	1,339	NNN—
	Padre Island, Tex.	2 June 1981	5	NNA—
	Galveston, Tex.	28 Sept. 1981	1	K— J0096
1980	Padre Island, Tex.	2 June 1981	1,526	NNB—
	Campeche Bay, Mex.	3 Mar. 1981	197	K— 8001-1800 (inconel)
1981	Padre Island, Tex.	2 June 1982	1,521	NNG—
	Sabine Pass, Tex.	14 July 1982	118	NNH—
1982	Padre Island, Tex.	7 June 1983	1,159	NNL—
	Nueces Bay, Tex.	7 June 1983	96	NNM—
	Sabine Pass, Tex.	15 July 1983	69	
	Mustang Island, Tex.	5 June 1983	1	
1983	Mustang Island, Tex.	5 June 1984	190	NNQ—
1984	Padre Island, Tex.	21 May 1985	1,017	NNT— NNV—
1985	Copano Bay, Tex.	22 Apr. 1986	519	NNX— (inconel)
	Padre Island, Tex.	6 May 1986	961	NNY— (inconel)
	Galveston, Tex.	28 Sept. 1986	54	
1986	Padre Island, Tex.	21 Apr. 1987	1,630	PPK— (inconel) PPL— (inconel)
Total			12,422	

[1]Monel tags, unless noted otherwise. Each dash represents a numerical digit from 0 to 9; actual numerical series can be obtained from the NMFS SEFC Galveston Laboratory, 4700 Avenue U, Galveston, TX 77551.

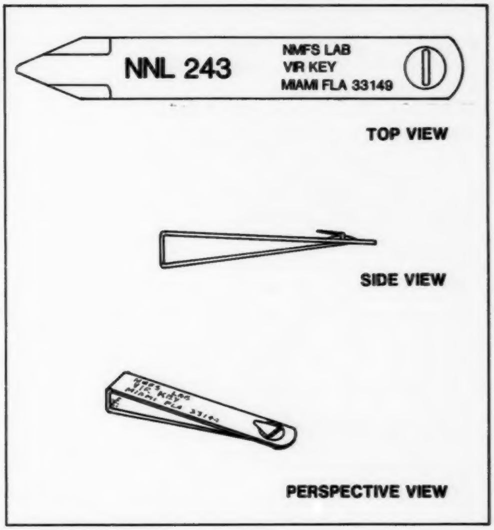


Figure 1b.—Illustration of flipper tag used on head-started Kemp's ridley sea turtles showing letter-number code and address to mail tag recovery information.

Distributional Grouping

To relate distribution of tag recoveries to the release site, the recoveries were categorized into three groups: 1) Florida released turtles, 2) Texas nearshore and offshore released turtles, and 3) Texas bay released turtles. Tag recoveries from the Campeche Bay release were not included in this distributional analysis because of the number (5), but are included in all other analyses in the paper. Within each group, tag recoveries were assigned arbitrary straight line distances, over water, from release site to recovery locations to correlate distance from release site with time at large. The arbitrary distances and number of days in the wild were then assigned ranks and a Spearman Rank Correlation was calculated (Sokal and Rohlf, 1981).

Classification of Tag Recoveries

All tag recoveries were categorized by inshore or offshore habitat, method of recovery, and season. Categories are defined as follows, with coastal waters being divided into two habitats: 1) Bay waters = any body of water recessed from the main coastline or landward of barrier islands, and 2) Gulf/ocean waters = any major body of water bordering the main coastline or seaward beach of a barrier island. Tag recovery methods included: 1) Shrimp trawl = turtles caught and reported by a shrimper, 2) hook and line = turtles caught on a baited hook by recreational fishermen, 3) stranded dead or alive = turtles found washed up on a beach or in the surf zone, 4) swimming = instances where turtles were scooped from the water by hand, and 5) unknown = no method or source of tag recovery reported. Season: 1) Spring = April, May, June; 2) summer = July, August, September; 3) fall = October, November, December; and 4) winter = January, February, and March.

Results

Tag Recoveries by Year Class

Of 12,422 head-started Kemp's ridleys released between 22 February 1979 and 4 April 1987, 547 (4.4 percent) tag recoveries were reported as of 31 December 1987 (Table 2). Recovery numbers ranged from a low of 11 (2.0 percent) for the 1983 year class to a high of 156 (28.5 percent) for the 1982 year class. However, 69 (44.2 percent) of the 1982 year class tag recoveries were reported within the first 14 days after release, an unusually high recovery rate in such a short period of time. This anomalous rate may have been related to two factors: 1) This was the only year class released in nearshore waters, between 6-10 km (4-6 miles) off the beach, and 2) the turtles were released into floating patches of sargassum weed on the expectation that sargassum would provide food and cover. Most of the turtles that washed ashore were coated with oil or had ingested tar balls probably associated with the sargassum. Because of this anomaly, turtles of the 1982 year class found washed ashore during that 14-day period were eliminated to reduce bias. Therefore, the total number of recoveries used in our analyses was 478.

Other unusual events affected the data for the 1983 and 1985 year classes. A poor hatch (12 percent) of the 1983 year class at Padre Island resulted in only 230 hatchlings for head starting. What caused the poor hatch is not fully known. Only 190 turtles of the 1983 year class survived for release. The 1985 year class had an unusual steady stream of tag recoveries within the first 60 days after release. The high recovery rate over this time period is discussed later.

Table 2.—Summary of released head-started Kemp's ridley sea turtles and tag recoveries for 1978-1986 year-classes.

Year class	No. released	No. of tag recoveries	Percent
1978	2,019	75	13.7
1979	1,345	21	3.8
1980	1,723	86	15.7
1981	1,639	51	9.3
1982	1,325	156	28.5
1983	190	11	2.0
1984	1,017	23	4.2
1985	1,534	108	19.7
1986	1,630	16	2.9
Totals	12,422	547	4.4

Table 3.—Summary of tag recoveries by state or nation for head-started Kemp's ridley sea turtles of the 1978-86 year classes.

State/ nation	Recoveries No.	Recoveries %	State/ nation	Recoveries No.	Recoveries %
Texas	291	60.9	France	2	0.4
Louisiana	67	14.0	Maryland	2	0.4
Florida	49	10.3	New Jersey	2	0.4
N. Carolina	19	4.0	New York	2	0.4
S. Carolina	12	2.5	Virginia	2	0.4
Georgia	10	2.1	Morocco	1	0.2
Mexico	7	1.5	Not Reported[1]	2	0.4
Mississippi	6	1.3			
Alabama	4	0.8	Totals	478	100.0

[1]Not enough information collected to determine location.

Distribution

The highest frequency of tag recoveries, 291 (60.9 percent), occurred in Texas (Table 3). Louisiana, Florida, North Carolina, and South Carolina followed with 67 (14.0 percent), 49 (10.3 percent), 19 (4.0 percent), and 12 (2.5 percent), respectively. Of the 478 tag recoveries, 175 (36.6 percent), occurred within 60 days of release (Fig. 2) and were relatively close to the site of release. Tag recoveries that occurred 60 days or longer after release were more widely distributed and similar to the historical distribution and range of wild Kemp's ridleys (Carr, 1952, 1957; Carr and Caldwell, 1958; Pritchard and Marquez, 1973; Hildebrand, 1982; Brongersma, 1972; and Fontaine et al., In press b).

Florida Releases

Turtles released off the west and southwest coasts of Florida accounted for 92 tag recoveries (Fig. 3). Sixty-one (66 percent) were reported from the Atlantic compared with 31 (34 percent) from the Gulf of Mexico. Forty-two (46 percent) tag recoveries were reported from Florida (both Atlantic and Gulf). Days at large for these turtles ranged from 1 to 459, with a mean of 111. Days at large for Florida-released turtles reported from other states was from 15 to 1,563, with a mean of 623. Turtles found shortly after release remained relatively close to the release site while turtles at large for longer periods were further from the site of their release. The positive Spearman Rank correlation coefficient for the relationship between ranks of distances and time at large was $rs = 0.991$ and significant ($P<0.05$), supporting the conclusion that distances from release site increased with time at large,

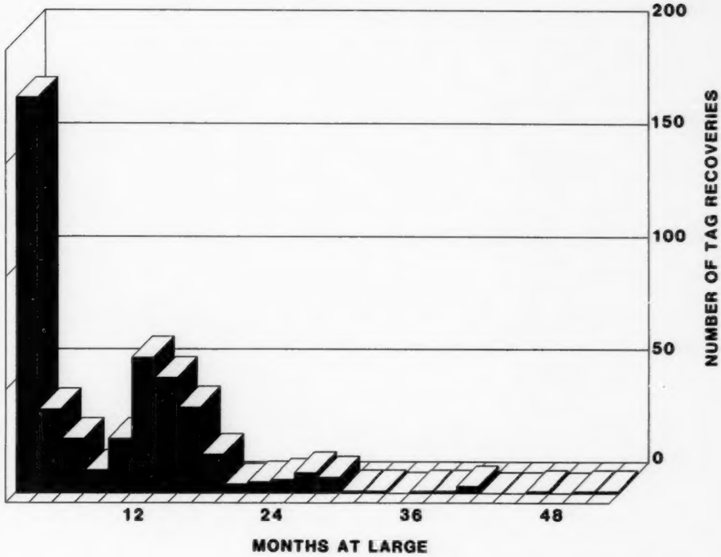


Figure 2.—Frequency distribution of months at large for 478 head-started Kemp's ridley sea turtle tag recoveries of the 1978-86 year classes.

as might be expected.

The percentage of tag recoveries reported outside Florida and in the Atlantic was 45.6 percent. Head-started turtles are no longer released off the Florida coast because it has not been determined whether Kemp's ridleys in the Atlantic return to the breeding population in the Gulf[2].

Texas Releases

Texas nearshore and offshore releases accounted for 295 tag recoveries (Fig. 4). Two hundred eighty-four (96.3 percent) tag recoveries were reported from the Gulf of Mexico and 11 (3.7 percent) from the Atlantic. Of the 295 tag recoveries 202 (68.5 percent) were reported from Texas. Days at large ranged from 1 to 1,210, with a mean of 229. Days at large for the 93 tag recoveries reported from other states ranged from 13 to 1,394, with a mean of 367. In this group of turtles, the relationship between ranks of distance from release site and time at large is supported by a significant positive correlation, $rs = 0.532$ ($P < 0.05$), but less strongly than the Florida group.

For the Texas bay releases, represented by 86 tag recoveries, distribution was very localized with 80 (93.0 percent) reported within the bay system in which the turtles were originally released (Fig. 5). Days at large for tag recoveries representing the Nueces Bay release ranged from 52 to 302 days with a mean of 129, and recoveries from the Copano Bay release ranged from 4 to 526 days with a mean of 105. Only three turtles (3.5 percent) were reported from offshore beaches or waters where days at large for tag recoveries ranged from 36 to 390 days with a mean of 263. Even though the Spearman rank correlation, $rs = 0.986$ ($P<0.05$), was large and significant, the ranks were clustered in only two widely separated groups. This resulted because all turtles found within the bay systems were arbitrarily assigned the same distance rank; thus, these turtles were clustered at the lower end of the scale. The turtles outside the bays were clustered at the other end of the scale of ranks. We feel that turtles released in the bays remained there for long time periods and stayed relatively

[2]Ogren, L. The biology and ecology of juvenile sea turtles: Kemp's ridley (*Lepidochelys kempi*) in the Gulf of Mexico and Western North Atlantic. Unpubl. rep., NMFS Southeast Fisheries Center, Miami, Fla.

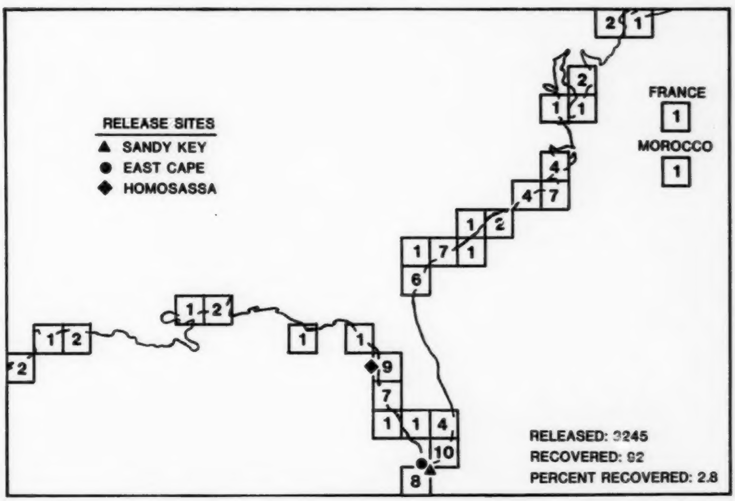


Figure 3.—Distribution of head-started Kemp's ridley sea turtle tag recoveries of the 1978-86 year classes released off Florida. Numbers represent tag recoveries in each one degree block; turtles without latitude and longitude of recovery not included.

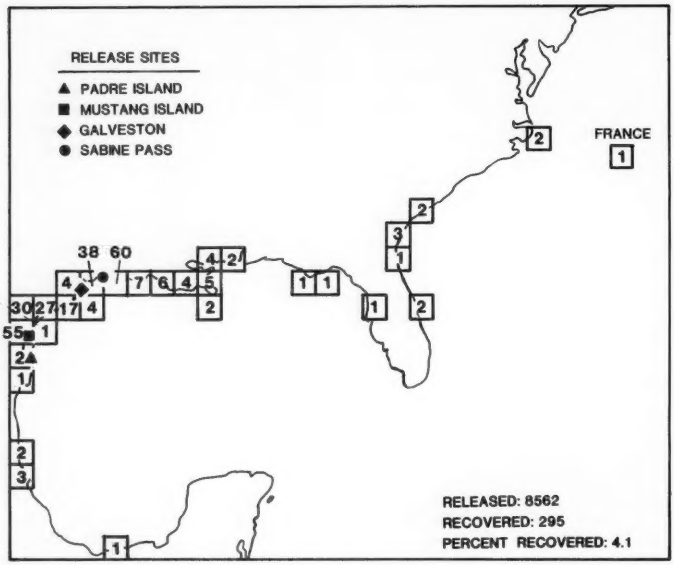


Figure 4.—Distribution of head-started Kemp's ridley sea turtle tag recoveries of the 1978-86 year classes released off Texas. Numbers represent tag recoveries in each one degree block; turtles without latitude and longitude of recovery not included.

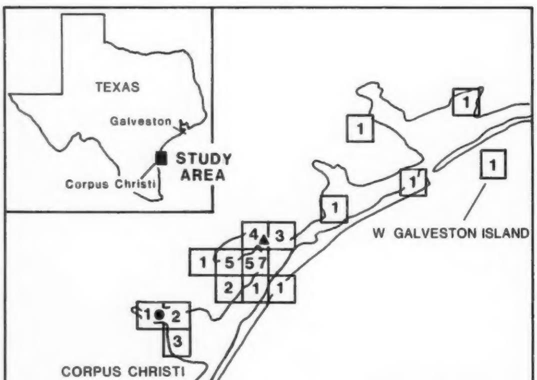


Figure 5.—Distribution of head-started Kemp's ridley sea turtle tag recoveries of the 1982 and 1985 year classes released in Texas Bays. Numbers represent tag recoveries in each six-minute block; turtles without latitude and longitude of recovery not included.

close to the site of their release in contrast to animals released offshore of the Florida and Texas coasts.

Habitat

Head-started Kemp's ridley tag recoveries occurred in bays and Gulf/ocean waters almost equally. Of 478 tag recoveries, 219 (45.8 percent) were reported from bay waters, 152 (31.8 percent) from Gulf/ocean waters, and habitat could not be determined for 107 (22.4 percent) turtles (Fig. 6). Turtles released in nearshore or offshore waters accounted for 140 (35.8 percent) tag recoveries from bay waters.

Table 4.—Summary of tag recovery methods for head-started Kemp's ridley sea turtles of the 1978-86 year classes.

	Recoveries			Recoveries	
Method	No.	%	Method	No.	%
Shrimp trawl	132	27.6	Dip net	5	1.1
			Swimming	4	0.8
Unknown	123	25.7	Cast net	2	0.4
Stranded			Butter-fly net	2	0.4
Dead	116	24.3			
Alive	48	10.0	Beach seine	1	0.2
Hook and line	27	5.7	Crab pot	1	0.2
Gill net	17	3.6	Totals	478	100.0

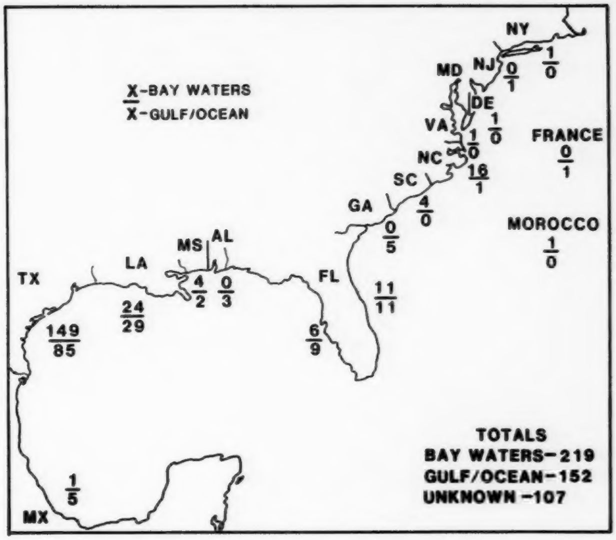
Tag Recovery Methods

Altogether 132 (22.6 percent) head-started turtles were caught in shrimp trawls (Table 4) and 89 (69.5 percent) of these were reported alive and released. One hundred sixteen (24.3 percent) turtles were reported as stranded dead and 48 (10.0 percent) were reported as stranded alive. Recreational fishermen reported 27 (5.7 percent) head-started turtles caught by hook and line, while two (0.4 percent) were taken in cast nets. For 123 (25.7 percent) turtles the method of tag recovery was not reported.

Tag Recoveries by NMFS Statistical Subareas

All tag recoveries were summarized by NMFS shrimp statistical subareas (used to compile shrimp catch and effort statistics). Figure 7 presents the numbers of tag recoveries within each subarea for the Gulf and Atlantic coasts. The largest number, 152 (31.8 percent), were reported from statistical subarea No. 19, encompassing Copano Bay and Nueces Bay release areas. Subarea 20, the Padre Island release area, was second with 65 (13.6 percent) tag recoveries. Two of the more productive statistical subareas for shrimp harvesting, No. 17 near Cameron Parish, Loui-

Figure 6.—Bay tag recoveries vs. Gulf/ocean tag recoveries of head-started Kemp's ridley sea turtles of the 1978-86 year classes. Top number represents turtles from Bay waters. The numbers are located off the state where tag recoveries were reported.



siana and No. 18 near the Galveston/Sabine pass area, reported 63 (13.2 percent) and 46 (9.6 percent) tag recoveries respectively.

Turtle Status

At the time of tag recovery, 274 (57.3 percent) turtles were reported alive, 166 (34.7 percent) dead, and the status of 38 (7.9 percent) turtles was not reported (Fig. 8). Of the live recoveries, 252 (92 percent) were reported as released and the others held for rehabilitation.

Season

Most of the tag recoveries, 251 (52.5 percent) were reported in spring and 139 (29.1 percent) were reported in summer. The number of tag recoveries decreased during fall and winter (Fig. 8).

Multiple Tag Recoveries

There were 25 turtles captured more than one time. Some of these were worth noting. The 1978 year-class turtle with tag G0045 was captured twice, both times in Core Sound, N.C. This animal was first taken on 25 November 1980, 642 days after release in Sandy Key, Fla., in February 1979 and second, on 21 June 1981, 208 days after the first capture. Another 1978 year-class turtle with tag G0914 was first captured in Beaufort, N.C., on 20 August 1980, 470 days after release in Homosassa, Fla., in May 1979, and for a second time in Hampstead Bay, N.C., on 9 July 1983, 1,053 days (3.5 years) after the first capture. These turtles seem to have stayed in about the same areas and may have overwintered on the North Carolina coast. One other turtle of the 1978 year class, tag G0104, was captured in Miami, Fla., 46 days after release in February 1979 at Sandy Key, Fla. The turtle was captured a second time in Ocean City, Md., 731 days after the first capture. In Bradley Beach, N.J., 56 days after the second capture, the turtle was caught a third time (Fontaine et al., In press b). This turtle seemed to move northward and may have wintered in the Mid-Atlantic region.

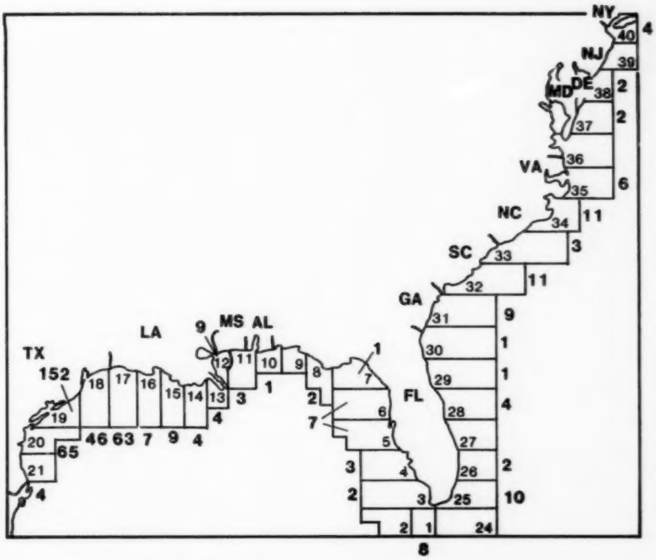


Figure 7.—Tag recoveries of head-started Kemp's ridley sea turtles of the 1978-86 year classes summarized by NMFS shrimp statistical subareas. The numbers on the outside of the subarea boundaries represent the numbers of tag recoveries from that subarea. Turtles without latitude and longitude of recovery not included.

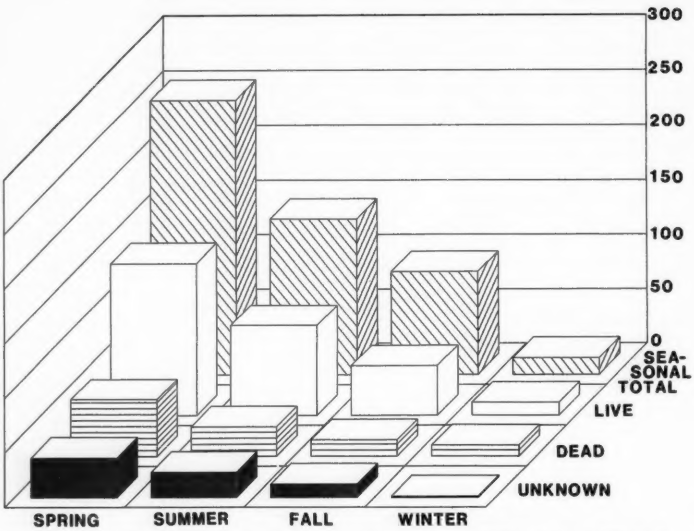


Figure 8.—Turtle status and season of tag recoveries for 478 head-started Kemp's ridley sea turtles of the 1978-86 year classes.

Three other turtles, one from the 1984 year class and two from the 1985 year class also have very interesting tag recovery information (Fig. 9). The 1984 year-class turtle with tag NNT906, released off Padre Island, Tex., on 21 May 1985, was taken in a shrimp trawl in Aransas Pass, Tex., on 6 October 1985, 138 days after release. The turtle was rereleased unharmed. This same turtle was again taken in a shrimp trawl in Matagorda Bay, Tex., on 25 August 1986, 323 days after the first capture. This turtle moved from offshore waters to inshore waters.

The 1985 year-class turtle with tag NNX203 was released in Copano Bay, Tex., on 22 April 1986 (Fig. 9). On 6 May 1986, 14 days later, this turtle was taken in a shrimp trawl in Aransas Bay, Tex., and was rereleased unharmed. On 17 May 1987, 376 days after the first capture, turtle NNX203 was found stranded on West Galveston Island, Tex. The turtle, in very bad condition, was taken to the NMFS Galveston Laboratory for rehabilitation and has since been released. This turtle moved from inshore waters to offshore waters and is one of only three turtles released in a bay and found in Gulf waters.

Another 1985 year-class turtle, tag NNX270, was released in Copano Bay, Tex., and was captured three times (Fig. 9), first, on 22 January 1987 stranded in the mud near Rockport, Tex., 275 days after release. The turtle was badly emaciated, suffering from cold shock and very white in color. The carapace was covered with mud and bits of algae indicating it might have been burrowing on the bottom[3]. The University of Texas Marine Science Institute at Port Aransas rehabilitated this turtle and released it for the second time with the 1986 year class on 21 April 1987 about 19 km (12 miles) off Padre Island, Tex. On 9 May 1987, 18 days after this second release, turtle NNX270 was found basking in 36 inches of water in Matagorda Bay near Palacios, Tex. The turtle was scooped up with a dip net and later rereleased unharmed. On 3 July 1987, 55 days after the second capture, this same turtle was taken in a shrimp trawl in Matagorda Bay, this time near Port Lavaca, Tex. The turtle was reported as alive and very active and was rereleased unharmed. The movement of this turtle is especially interesting. First, it was found near its release location in Copano Bay, possibly attempting to over-winter. After rehabilitation and release offshore, the turtle had returned to the bay system and showed signs of having stayed there for some time.

[3]Pamela Plotkin, University of Texas Marine Science Institute, Port Aransas, TX 78373. Personal commun., Jan. 1987.

Trans-Atlantic Recoveries

Three trans-Atlantic tag recoveries were reported; two from Biarritz, France, and one from El Jadida, Morocco. Of the two turtles reported from France, one, tag NNN893, from the 1979 year class released off Homosassa, Fla., in June 1980, was found in December 1981, 568 days after release. It was alive when found on the beach, apparently suffering cold shock. The second turtle from Biarritz, tag NNG042, was from the 1981 year class released off Padre Island in June 1982. It was found stranded and dead 1,394 days after release. Turtle with tag NNN678, found stranded on a beach in Morocco, was from the 1979 year class released off Homosassa, Fla., in June 1980. The turtle was reported alive 898 days after release. The tag was removed and the turtle rereleased. This may well be the first authenticated report of a Kemp's ridley from the coast of Africa (Fontaine et al., In press b).

Discussion

Tag recoveries of head-started Kemp's ridleys were widely distributed but centered around the Western Gulf of Mexico where most of the turtles were released and close to the area where the second nesting site was proposed. Turtles reported within 60 days after release were usually relatively close to the release site, and turtles at large for over 60 days appeared to be distributed in the same pattern and areas as historical records show for wild Kemp's ridleys. One exception is the tag recovery from Morocco which may represent an extension of the range for the species.

In an earlier study in which a small number of head-started Kemp's ridleys were released with radio tags and tracked for 30 days, the turtles behaved normally (Klima and McVey, 1982; Wibbels, 1984). After remaining in the

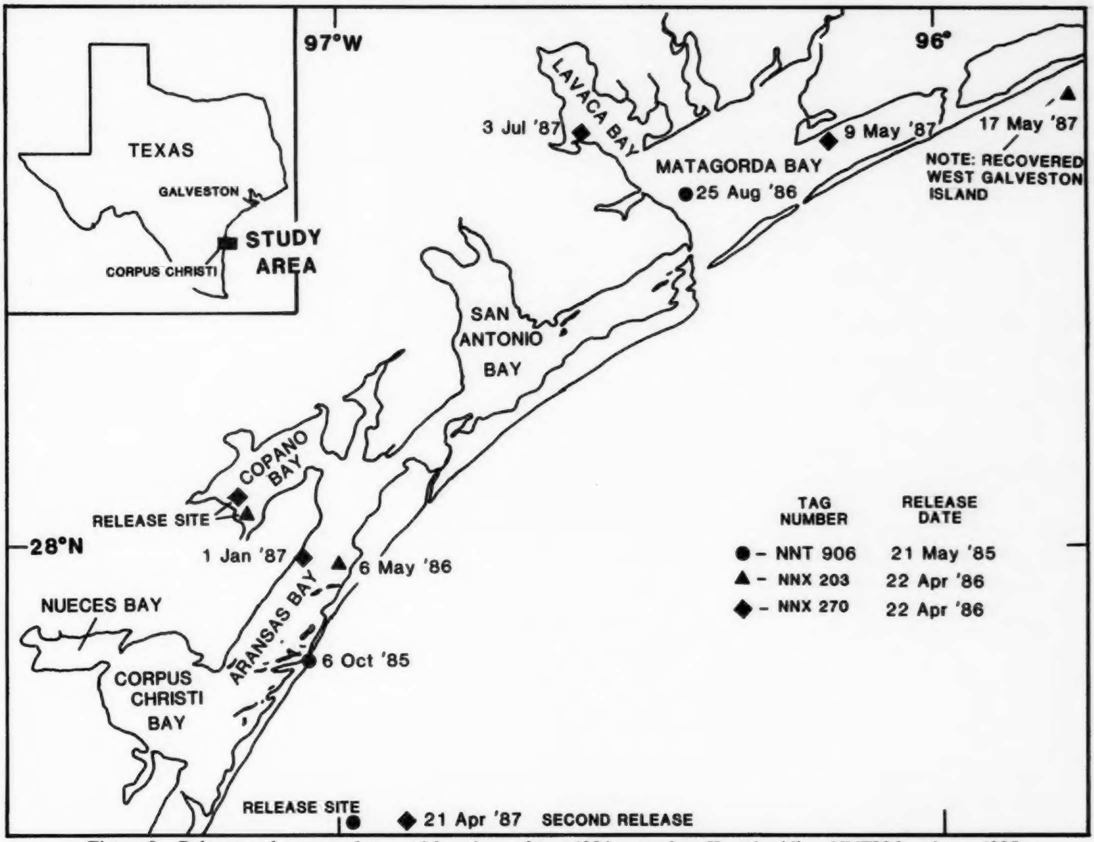


Figure 9.—Release and capture dates and locations of one 1984 year class Kemp's ridley, NNT906 and two 1985 year class Kemp's ridleys, NNX203 and NNX270.

release area a few days, the turtles showed some movement, but generally stayed in the same area throughout the tracking period. Wibbels (1984) concluded that both ocean currents and the turtles' swimming played important roles in the dispersal of the animals.

The head-started turtles have shown movement to and from bay systems. The turtles probably enter the bays and shallow coastal waters in search of the abundant food available there. Carr (1957, 1980), Hildebrand (1982), and Ogren[2] reported that ridleys are commonly found in bays and shallow coastal areas. Lutcavage and Musick (1985) observed that ridleys frequently occurring in the Chesapeake Bay system use that area as a summer feeding ground. Another known U.S. feeding ground is off the coast of Louisiana, from Marsh Island to the Mississippi Delta (Hildebrand, 1982). Shrimp, *Penaeus* sp., and blue crab, *Callinectes sapidus*, a favorite food item of the Kemp's ridley[2], are abundant in those areas. By species, the Kemp's ridley is the second most common sea turtle found stranded in the inshore habitat, with the green sea turtle, *Chelonia mydas*, the most common. Of all wild Kemp's ridley strandings reported to the Sea Turtle Stranding and Salvage Network (STSSN), 22.1 percent are found in the inshore areas[4].

Kemp's ridleys, especially juveniles, inhabit many of the same areas where shrimp and crab occur so it is not unusual that a large number of these turtles are caught in shrimp trawls. Liner (1954) reported eleven Kemp's ridleys caught in shrimp trawls off the Louisiana coast, and Ogren[2] reported that: "Localities where unusual numbers of juvenile ridleys were captured incidental to trawling efforts have been reported since mid 1970's. They are (1) Sabine River offing—Sea Rim State Park, Texas, (2) Terrebonne Parish, Caillou Bay, Louisiana; and (3) Big Gulley, adjacent Mobile Bay offing."

Further, Ogren added that: "These events may have been unusual in that they are thought to be correlated with

[4]Barbara Schroeder, NMFS Miami Laboratory, 75 Virginia Beach Dr., Miami, FL 33149. Personal commun., Sept. 1987.

a high density or abundance of blue crab resulting in a concentration of foraging ridleys."

The 1985 year class, mentioned earlier for the unusual continuous stream of tag recoveries within 60 days after release, had 65 reported within that time period. Fifty-two of these were turtles that stranded in the Copano Bay area and had originally been released into this bay assuming that it would provide a good habitat and that it was closed to shrimping at the time of release. Eight of the tag recoveries were reported as taken by shrimp trawls. David Owens[5] reported to the Kemp's ridley recovery team in 1986 after performing necropsies on 77 Kemp's ridleys that had stranded dead in Texas (47 of them head-started turtles from the Copano Bay release). He concluded that 53 were "possible trawling mortalities." The turtles appeared to have traumatic internal injuries including ruptured hearts.

According to Owens: "The general picture is that the turtles are primarily eating crabs (68%), with many of the head start animals in this group. Unfortunately, two lines of evidence suggest that the turtles are learning to go after discarded trawler by-catch. First, they often have fish in their guts which they could not normally catch.... Second, many that have crabs and fish in the gut also have the small gastropod scavenger *Nassarius*, a strong indication that the food was already dead when it was consumed by the turtle."

Usually, the cause of death of a stranded turtle is not apparent. Even though most head-started turtles caught in trawls were reported to have been released alive, the actual condition of the turtles was not known and some of the stranded animals may have originally been taken by shrimp trawls.

Recreational fishing may also play an important role in the incidental capture of sea turtles. The STSSN reports that of all wild sea turtles that are incidentally taken and reported to the network, 21.7 percent are associated with recreational fishing[4].

The highest number of tag recoveries was reported in the spring. This could be related to several factors: 1) Spring is the usual time for release of head-started turtles; almost 37 percent of the recoveries occur within two months after release (Fig. 2); 2) an increase in recreational activities along the coast increase the chances of a stranded turtle being found along the beaches, and 3) an increase in recreational and commercial fishing occurs.

The head-started Kemp's ridleys seem to adapt well after release into the wild, and the captive-rearing objective of the head start project has been proven successful. When a nesting Kemp's ridley can be identified as a head-started animal, the overall project will be a complete success.

[5]Owens, David. 1986. Texas A&M University, Dept. of Biology, College Station, TX 77843. Unpubl. rep. to Kemp's ridley recovery team, 4 August 1986.

Acknowledgments

We thank Rene Marquez Millan and the staff of Instituto Nacional de la Pesca of Mexico, Jack Woody and the staff of U.S. Fish and Wildlife Service, Albuquerque, N.M., and Milford Fletcher and the staff of National Park Service, Padre Island National Seashore. Ed Klima of the NMFS SEFC Galveston Laboratory provided administrative support and we are grateful for the efforts of the staff of the head start project, especially Ted Williams and Kathy Indelicato. We greatly appreciate the help of Dan Patlan and Dennis Koi for preparation of some of the figures and Zoula Zein-Eldin for reviewing the manuscript. Other thanks go to Texas Parks and Wildlife Department and to Carole Allen and H.E.A.R.T. (Help Endangered Animals-Ridley Turtles). The head start project is conducted under permits from the Mexican Government, the U.S. Fish and Wildlife Service, and the Texas Parks and Wildlife Department.

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Impacts of the Explosive Removal of Offshore Petroleum Platforms on Sea Turtles and Dolphins

EDWARD F. KLIMA, GREGG R. GITSCHLAG, and MAURICE L. RENAUD

ABSTRACT—Strandings of 51 dead sea turtles (primarily Kemp's ridley, Lepidochelys kempi*), 40 dolphins (primarily bottlenose dolphin,* Tursiops truncatus*) and many fish were recorded on beaches in the northwestern Gulf of Mexico from 19 March to 19 April 1986. During this period explosives were used to remove several oil platforms in adjacent offshore waters. Drift bottles released at the site of one of the explosions were recovered with some of the strandings. Shrimp fishing activity, a known cause of turtle mortality, was at a normal seasonal low. Circumstantial evidence suggests that at least some of the strandings of marine animals may have been due to underwater explosions used in removal of oil platforms.*

A total of 11 turtles were observed at 7 of 52 removal sites from 5 April 1986 through 5 August 1988, and a maximum of 100 dolphins were observed at each of 38 sites. One wild sea turtle was observed sinking after an explosion, but it could not be recovered to document its injuries. Necropsy of one stranded loggerhead turtle, Caretta caretta, *found two days after a 1987 removal showed hemorrhaging of the lungs which is consistent with impacts of an explosion; this condition may also be attributed to postmortem decomposition of tissue. In a preliminary experiment, two of four Kemp's ridley and three of four loggerhead turtles were rendered unconscious after placement within 915 m of the simultaneous explosion of four 23 kg charges.*

Comparison of turtle strandings during periods characterized by high and low numbers of offshore explosions, March-April 1985-88, suggested a positive relationship between the frequency of explosions and the stranding of turtles. Although dolphins may be impacted by explosions, the relationship between the stranding of dolphins and offshore explosions was not as conspicuous.

Introduction

Between 19 March and 19 April 1986, 51 dead sea turtles, primarily the endangered Kemp's ridley, *Lepidochelys kempi*, were found on beaches of the upper Texas coast. Ten petroleum structures were removed from this area when shrimping activity, a factor contributing to turtle mortality, was at a seasonal low (Fig. 1).

During the summer of 1986 the Interior Department's Minerals Management Service (MMS) and the Commerce Department's National Marine Fisheries Service (NMFS) discussed the effects of offshore explosions on endangered and threatened sea turtles. They agreed to hold formal consultations, as provided under Section 7 of the Endangered Species Act of 1973, for each proposed use of explosives in Outer Continental Shelf (OCS) waters of the Gulf of Mexico. Beginning in 1987, companies planning to remove oil and gas structures (platforms, caissons, well conductors, flare stacks, etc.) with explosives were required to obtain a permit from MMS. Permits authorized the use of explosives provided the company followed certain requirements which generally included: 1) Visual monitoring for turtles around the removal site by observers, approved by NMFS, operating from the work platform and frequently from helicopters, 2) pre- and post-blast diver surveys for sea turtles, 3) delaying detonations to allow observed turtles to leave the area, 4) detonating only during daylight hours to facilitate visual monitoring, and 5) staggering detonations to reduce the maximum pressure generated by the explosions.

High-velocity explosives are typically used to sever pilings and conductors 5 m below the mudline during removal operations. A crane then lifts these structures out of the water to a barge for return to shore. It is important to assess the potential impacts of these activities on sea turtles and other marine life. MMS estimates that there were 3,435 platforms in the Federal OCS as of December 1986, and predicts between 60 and 120 structures will be removed annually for the next 5 years. The National Research Council (NRCMB, 1985) estimates that about 1,700 structures will be scheduled for removal between 1984 and 2000. The Council predicts about 100-130 removals annually between 1990 and 2000.

This paper reports on 1) the relationship of explosive events with strandings of sea turtles and dolphins, 2) biological monitoring at 52 structure removal sites during 5 April 1986 through 5 August 1988, and 3) an experiment in which sea turtles were exposed to underwater explosions associated with the removal of a platform. Information pertaining to the association of turtles with offshore structures and the impacts of underwater explosions on turtles and dolphins is also discussed.

Materials and Methods

Sea Turtle Stranding Network

Since 1980, a sea turtle stranding network, operating primarily on a volunteer basis, has collected data from the U.S. Gulf of Mexico and Atlantic coasts.

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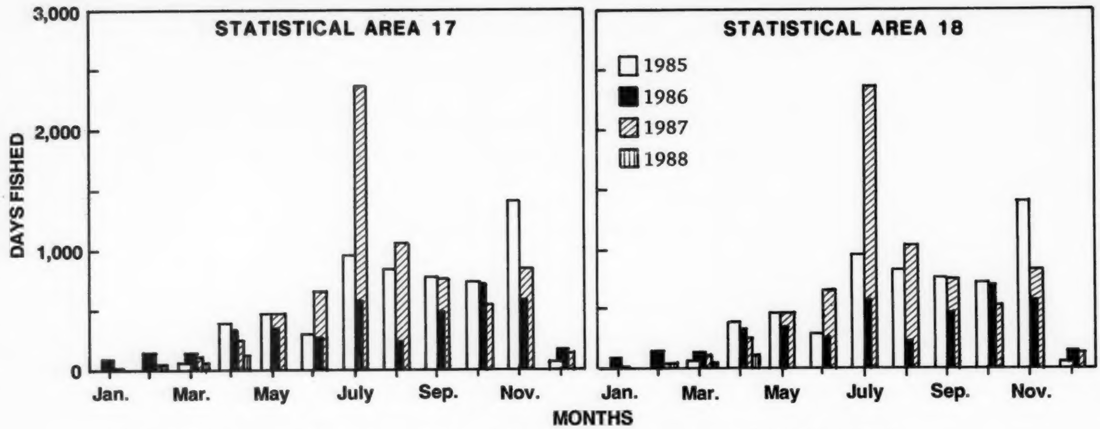

Figure 1.—Offshore shrimping effort in 0-18 m depths for Statistical Areas 17 and 18, 1985-88.

All information is centralized at the NMFS Miami Laboratory. The NMFS Sea Turtle Stranding and Salvage Network (STSSN) has been documenting beach strandings of turtles along the Texas and western Louisiana coasts through routinely scheduled surveys since the spring of 1986. Prior to this, NMFS surveyed the beach only in response to strandings reported by the public. Organizations supporting this network include the University of Texas Marine Science Center, McNeese State University, Louisiana Department of Wildlife and Fisheries, and the U.S. Fish and Wildlife Service.

Both the area and frequency of coverage have increased tremendously since inception of the program. Nearly all U.S. beaches along the Gulf of Mexico west of the Mermentau River, Louisiana, are surveyed biweekly if accessible by pickup truck, motorcycle, or all-terrain vehicle. Some estuarine and remote island shorelines have been included in the survey area. To assess the effects of explosions more accurately, surveys along the coastline were generally intensified near inshore platform removal sites both immediately prior to and following scheduled structure removal (Fig. 2).

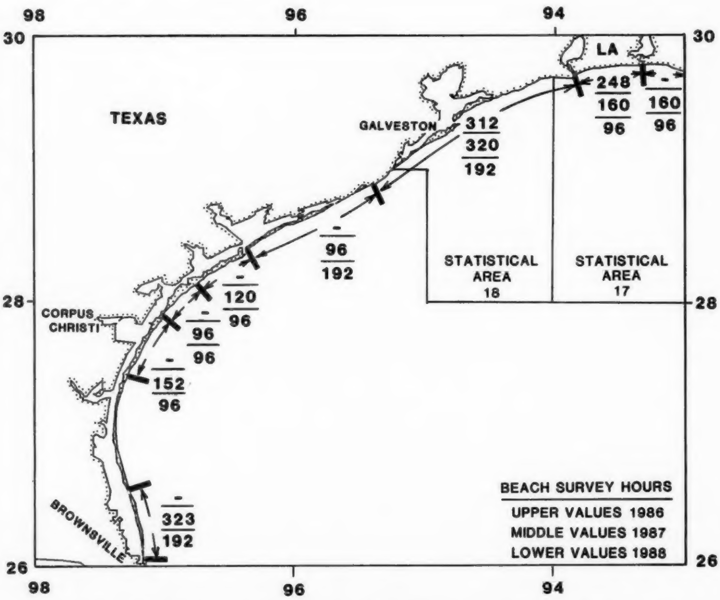

Figure 2.—NMFS-sponsored beach survey effort (man-hours) for monitoring turtle stranding events along the western coast of the Gulf of Mexico. Upper numerals represent 1986 hours, middle numerals 1987 hours and lower numerals 1988 (through June) hours expended on surveys of the coastline as indicated.

Marine Mammal Stranding Network

The National Marine Mammal Stranding Network operates primarily on a volunteer basis and responds to calls from the public. Organizers in various states report strandings to a central office in Orlando, Fla. Data in this paper were supplied by the Texas Marine Mammal Stranding Network, College of Veterinary Medicine, Texas A&M University. Information gathered through the NMFS Sea Turtle Stranding Network has assisted in the acquisition of data on marine mammal strandings.

NMFS Monitoring of Platform and Caisson Removals

Observers monitored the area around structure removal sites prior to, during, and after detonation of explosives (Fig. 3, Table 1). Pre-blast monitoring for sea turtles was conducted from 1) the work and/or materials barges, 2) the structure being removed, 3) tug boats or crew boats as available, and 4) helicopters, if required in the Section 7 consultation authorized by the Endangered Species Act. Observers used helicopters to survey around the removal site to a distance of 1.5 km. Thirty minute flights were made within 1 hour prior to, and immediately following, the detonations. Detonations were delayed 1 hour if sea turtles or marine mammals were observed within 915 m of the detonation site, and the survey was repeated, unless there was verification that the animals had moved beyond the 915 m range. Oil company divers made pre-blast dives around the structures to document the presence of sea turtles, marine mammals, and fish.

In all but one case, explosives were detonated no earlier than 1 hour after sunrise nor later than 1 hour before sunset. Following the detonations, dead or injured marine life were sampled on the bottom by divers and on the surface by personnel operating from a vessel. Observers in helicopters assisted this effort by communicating their observations to personnel collecting the animals. Fish were measured and identified. Drift cards were released at the removal sites in an attempt to document surface currents, and to assist in correlating the location of strandings with offshore explosions.

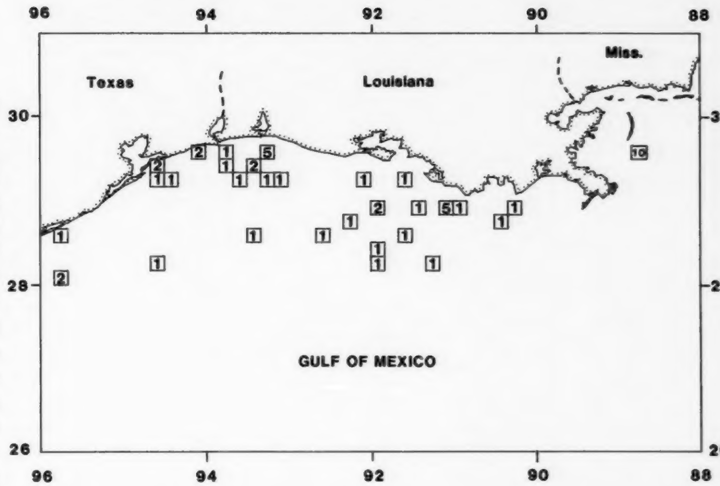

Figure 3.—Locations of NMFS monitored platform and caisson removals. The number of structures removed is indicated by numerals in the squares; 10 n.mi. on a side.

Exposure of Turtles to an Underwater Explosion

An experiment was designed to provide preliminary information on the extent of the impact zone created by the explosive removal of an offshore platform. Kemp's ridleys weighing 0.6, 1.3, 1.5, and 6.7 kg and loggerhead turtles, *Caretta caretta*, weighing 4.0, 4.2, 5.5, and 6.8 kg were placed in plastic mesh, steel-framed cages (0.9 m × 0.9 m × 1.2 m), one turtle of each species at four distances (229 m, 366 m, 549 m, and 915 m). Turtles were unrestrained and allowed to swim freely in the cages. All turtles had deformed flippers but were otherwise healthy, and all were permanent residents of the NMFS Southeast Fisheries Center's Galveston Laboratory. The cages were submerged to a depth of 4.5 m over the 9 m sea bottom just prior to the simultaneous explosion of four 23 kg charges of nitromethane placed inside the platform pilings at a depth of 5 m below the mudline. The energy level of the shock wave generated by the explosion was estimated by Cummings[1] for each of the four distances. Immediately following the explosion, turtles were retrieved and inspected carefully for external damage. Seabed drifters and drift bottles were released to define prevailing currents that might carry injured or dead marine animals ashore. All animals were transferred to the NMFS Galveston Laboratory and examined daily for the next month. The experiments were undertaken with the permission of the U.S. Fish and Wildlife Service under Permit No. PRT-676379.

[1]William Cummings, TRACOR, 9150 Chesapeake, Suite 107, San Diego, CA 92123. Unpubl. data.

Shrimp Fleet Fishing Effort

Detailed catch statistics for the U.S. Gulf of Mexico shrimp fishery have been compiled since 1956, and the procedures used to collect them are described by Klima (1980).

Results

Relationship of Explosive Events With Strandings of Marine Life

A series of at least 22 explosions occurred between 19 March and 5 April 1986 in conjunction with oil field structure removals within 7-11 km of the Bolivar Peninsula, near Galveston, Tex. (Table 2). During this period and the following 2 weeks 51 dead turtles were found on beaches in Statistical Area 18 which includes Bolivar Peninsula and Galveston Island (Fig. 4). Of the 51 turtles stranded, 25 (49 percent) were reported within an 11 km radius and 44 (86 percent) within a 54 km radius of the structures that were removed. Forty-

Table 1.—Man-hours of observation at NMFS monitored removals with accompanying sightings of turtles and dolphins. Refer to Figure 3 for platform locations.

Date of removal	Approx. distance from shore (n.mi.)	Depth (m)	Structure removed	Man-hours of observation (day/night)	Turtles sighted	Dolphins sighted
4/86	1	9	Platform	8/0	0	26
7/86	75	42	Platform	76/48	4	18
11/86	10	15	Platform	28/14	0	0
12/86	6	12	Caisson	11/0	0	7
12/86	9	12	Caisson	10/0	0	8
3/87	55	39	Platform	52/45	2	24
4/87	21	16	Caisson	13/0	1	13
6/87	17	27	Platform	73/0	0	26
9/87	15	10	Caisson	9/0	0	9
9/87	18	15	Caisson	7/9	0	1
9/87	18	15	Caisson	14/3	0	30
10/87	80	72	Platform	99/20	0	0
11/87	35	20	Platform	53/8	0	2
11/87	60	56	Platform	146/37	0	27
1/88	32	12	Platform	80/33	0	0
1/88	32	9	Platform	26/2	0	0
2/88	25	17	Platform	56/14	1	30
2/88	10	8	Platform	32/8	0	10
2/88	40	33	Platform	32/15	0	16
2/88	51	71	Platform	35/9	0	100
2/88	13	12	Caisson	10/2	0	1
2/88	12	11	Caisson	30/0	0	2
2/88	13	11	Caisson	8/2	0	3
3/88	14	12	Caisson	10/0	0	0
3/88	13	12	Caisson	10/0	0	1
3/88	55	17	Platform	32/9	0	0
4/88	64	49	Platform	82/48	0	51
4/88	62	58	Platform	37/5	0	0
4/88	28	43	Platform	108/31	0	28
4/88	28	43	Platform	12/4	0	1
5/88	30	21	Caisson	42/25	0	4
5/88	30	21	Caisson	43/25	0	3
5/88	13	4	Caisson	11/4	0	15
5/88	21	8	Caisson	7/1.5	0	0
5/88	21	8	Caisson	3/0	0	0
5/88	21	7	Caisson	4.5/0	0	0
5/88	21	7	Caisson	2.5/0	0	0
5/88	21	6	Caisson	3/0	0	0
5/88	9	11	Platform	25/4	0	0
6/88	9	19	Caisson	73/63	0	20
6/88	65	20	Caisson	9/5	0	0
6/88	66	19	Caisson	11/5	0	1
6/88	66	22	Caisson	19.5/2.5	0	10
6/88	63	18	Caisson	8/5	0	12
6/88	62	19	Caisson	11/2	1	10
6/88	62	17	Caisson	7/5	0	1
6/88	63	19	Caisson	8/1	0	20
6/88	64	19	Caisson	5/0	0	3
6/88	64	19	Platform	1.5/1.5	0	1
7/88	21	8	Platform	56/29.5	0	27
8/88	8	20	Platform	22.5/11	1	3
8/88	13	21	Platform	44/0	1	0

Table 2.—March-April 1986 schedule of removals of oil and gas field structures off Bolivar Peninsula. The total weight (kg) of explosives utilized at each detonation and the number of turtles and dolphins stranded in Statistical Area 18 during this time period are also presented.

Date	Weight of explosives (kg)	24 hr time	Approximate Lat.	Approximate Long.	Turtles	Dolphins
1-18 March					9	4
19	45	1632	29° 25′	94° 39′	0	3
	109	1758	29° 25′	94° 39′		
20	27	2235	29° 25′	94° 39′	1	0
21	109	1703	29° 25′	94° 39′	3	0
22	27	1130	29° 25′	94° 39′	0	0
23	27	0815	29° 25′	94° 39′	0	1
24	109	1425	29° 25′	94° 39′	0	0
25	45	1100	29° 25′	94° 39′	0	0
	76	1333	29° 25′	94° 39′		
26	18	1630	29° 25′	94° 39′	5	2
27	109	1220	29° 28′	94° 30′	1	0
	27	1440	29° 25′	94° 39′		
28	27	1545	29° 25′	94° 39′	3	0
29	27	0845	29° 25′	94° 39′	0	0
	109	1310	29° 25′	94° 39′		
	55	2330	29° 25′	94° 39′		
30	35	1020	29° 25′	94° 39′	3	14
31	109	1015	29° 25′	94° 39′	1	0
1 April	23	1710	29° 25′	94° 39′	2	4
2	76	0805	29° 25′	94° 39′	0	0
3					0	0
4					1	4
5	59	1251	29° 25′	94° 39′	2	1
	109	1451	29° 25′	94° 39′		
6-19					29	12
20-30					32	5

one bottlenose dolphins, *Tursiops truncatus*, 15 of which were apparently smaller than the usual size at birth (i.e., fetuses ≤120 cm total length), also stranded (Fig. 4). After two detonations (168 kg of explosive) on April 5, sheepshead, *Archosargus probatocephalus*; black drum, *Pogonias cromis*, and a variety of other fish species were observed floating on the surface. Perforated air bladders were found in five sheepshead collected in bottom trawls after the detonations (Landry[2]). Fifty-four sheepshead and 69 black drum were stranded along 22 km of beach immediately inshore of the removal site over the next 14 days (Fig. 5, 6).

Turtles

Beaches in Statistical Area 18 were surveyed for about 312, 320, and 192 man-hours in 1986, 1987, and through June 1988, respectively. In 1985, however, NMFS personnel examined the beaches in this area only in response to public reports of stranded marine life.

[2]Andre Landry, Texas A&M University, 5007 Avenue U, Galveston, TX 77551. Personal commun.

From 19 March to 19 April, nine turtle strandings were reported in Statistical Area 18 during 1985, 51 in 1986, 4 in 187, and 5 in 1988. Based on the state of decomposition of a turtle and the reported date of stranding, one turtle from each of the 1985 and 1986 data sets had died previous to the March-April sampling period.

At least 22 explosions were reported in Texas State waters of Area 18 during this period in 1986, one in Federal waters in 1987, and no explosions through June 1988. Comparison of turtle strandings during periods characterized by high and low numbers of offshore explosions (March-April 1986 vs. March-April 1987 and 1988, respectively) suggested a positive relationship between the frequency of explosions and the stranding of turtles (Fig. 7). Strandings of turtles in western Louisiana (Statistical Area 17) were minimal for 1985 (3 turtles), 1987 (30 turtles) and through June 1988 (3 turtles). However, 119 stranded turtles were reported between 1 May and 30 September 1986.

Two turtles were autopsied that were stranded on beaches within 2 weeks after explosions at monitored platforms.

One loggerhead showed no characteristics consistent with explosive impacts. External inspection of another loggerhead found dead 2 days following a nearshore explosion revealed a bloated carcass with green flesh and gas bubbles beneath the scutes. Necropsy showed lung hemorrhage, four ruptures of the right atrium, and bloody fluid in the pericardial sac (Landry[2]). Lung hemorrhage is consistent with impacts resulting from underwater explosions; however, this condition, along with ruptures in the heart, may also be the result of postmortem decomposition.

Marine Mammals

Between 19 March and 19 April six dolphins (all *Tursiops truncatus*) stranded in 1985, 41 (40 *T. truncatus* and 1 *Stenella* sp.) in 1986, 22 (*T. truncatus*) in 1987 and 22 (*T. truncatus*) in 1988 in Statistical Area 18. Of these, fifteen dolphins in 1986 and 12 in 1987 were considered either fetuses or newborns (length ≤120 cm). Based on state of decomposition and the reported date of stranding, one adult and two fetal dolphins in 1986 and one adult dolphin in 1987 had died before the 19 March to 19 April sampling period. Only three stranded dolphins were reported in Statistical Area 17 between January 1985 and December 1987. Data are not available for 1988 at this time. Although dolphins may be impacted by explosions, the relationship between the stranding of dolphins and offshore explosions was not as conspicuous (Fig. 8).

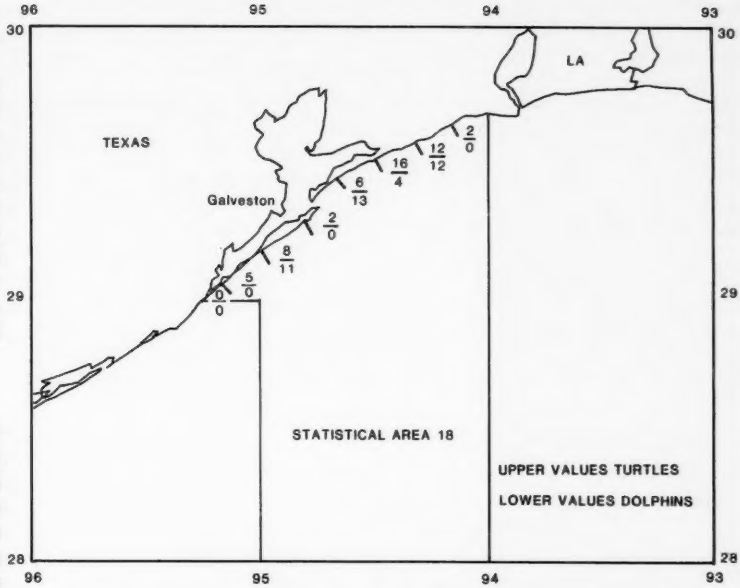

Figure 4.—Reported strandings of sea turtles (upper numerals) and dolphins (lower numerals) in Statistical Area 18 between 19 March and 19 April 1986.

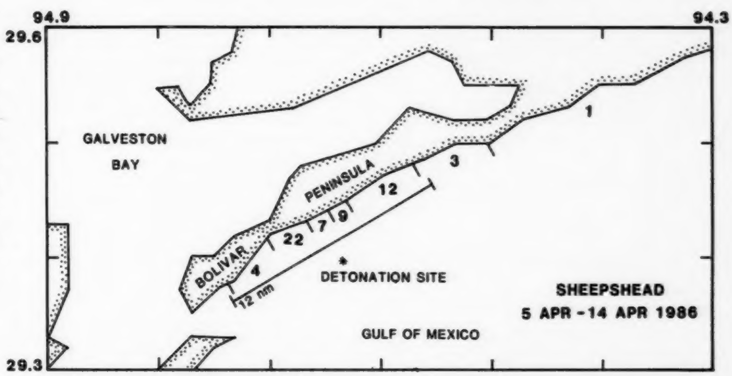

Figure 5.—Strandings of sheepshead reported on Bolivar Peninsula from April 5-19, 1986.

Biological Monitoring at Removal Sites

Turtles

A total of 11 turtles were observed at 7 of 52 removal sites monitored by NMFS (Table 1). One sighting of a green turtle, *Chelonia mydas*, and multiple sightings (4 and 6 observations) of two loggerhead turtles were made over a 4-day period near a platform 135 km off Sabine Pass just prior to its removal on 20-21 July 1986. After the first of six explosions an upside-down, motionless turtle, presumably a loggerhead, was observed drifting downcurrent about 6 m below the surface. Six sightings of loggerhead turtles were reported at five other removal sites, and a single observation of a green turtle, *Chelonia mydas*, was made at a seventh site. Turtles were observed under a variety of conditions ranging from pre- and post-blast helicopter surveys, routine fuel runs for helicopters, and from platforms and motor vessels.

On 1 August 1988 a loggerhead turtle was observed four times by NMFS observers during removal operations at an offshore oil platorm. On 3 August NMFS requested that the petroleum company conduct a diver survey to make sure no sea turtles were in the area prior to any detonations. The divers captured the loggerhead turtle (about 65 cm, straight shell length) apparently

sleeping under one of the cross members on the platform. The turtle was brought to the surface, held during detonation activities and eventually released unharmed at another platform. Six days later a turtle of similar size was captured and brought to the surface by NMFS divers during a night dive at the platform at which the first captured turtle was released. The turtle was sleeping on the sea floor under a horizontal plate (mud mat) on the platform that was raised about 40 cm off the bottom. Due to high seas and strong currents, the divers were unable to get the turtle aboard the ship for accurate identification, and the capture attempt was aborted.

Marine Mammals

Between 1 and 100 dolphins were observed at each of 30 of 52 removal sites monitored by NMFS (Table 1). On seven occasions the presence of dolphins delayed the scheduled detonation of explosives from times ranging from 11 minutes to 2 hours. Scaring dolphins with small explosive charges and herding dolphins with boats were not always effective in moving the dolphins away from the detonation site. The minimal effort expended on feeding dolphins to lure them from the removal site was unsuccessful.

Fishes

Dead fish were collected at 48 of 52 removal operations. Estimated fish kills ranged between 0-300 and 0-10,000 at caissons and platforms, respectively. The explosive removal of structures in water depths >20 m killed more fish than at shallower sites. An estimated 1,000-2,500 red snapper, *Lutjanus campechanus*, and several cobia, *Rachycentron canadum*, two species under Federal management, were killed at one removal site where water depth was 42 m. Post-blast samples of fish mortalities showed greater species diversity at deeper sites. The number of fish killed decreased with subsequent explosions at structures requiring multiple detonations.

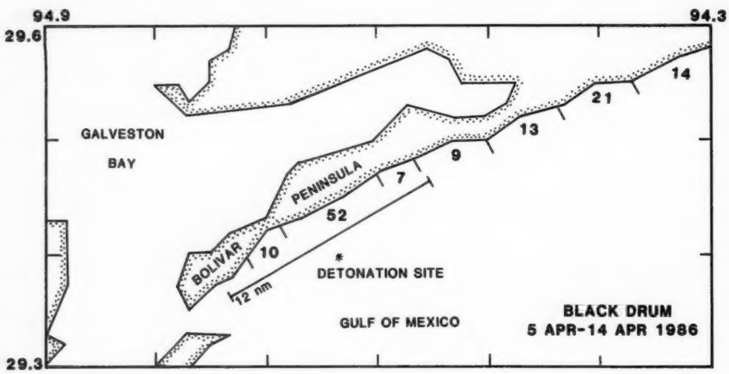

Figure 6.—Strandings of black drum reported on Bolivar Peninsula during 5-19 April 1986.

Exposure of Turtles to an Underwater Explosion

In June 1986, a platform off Bolivar Peninsula, Tex., was removed using 92 kg of explosives. Although in-water measurements of pressure levels were not recorded, values based on mathematical models were estimated to be 221, 217, 213, and 209 decibels (dB) for horizontal distances from the detonation site of 229 m, 366 m, 549 m, and 915 m, respectively (Cummings[1]). Two Kemp's ridleys (6.7 and 0.6 kg) and two logger-

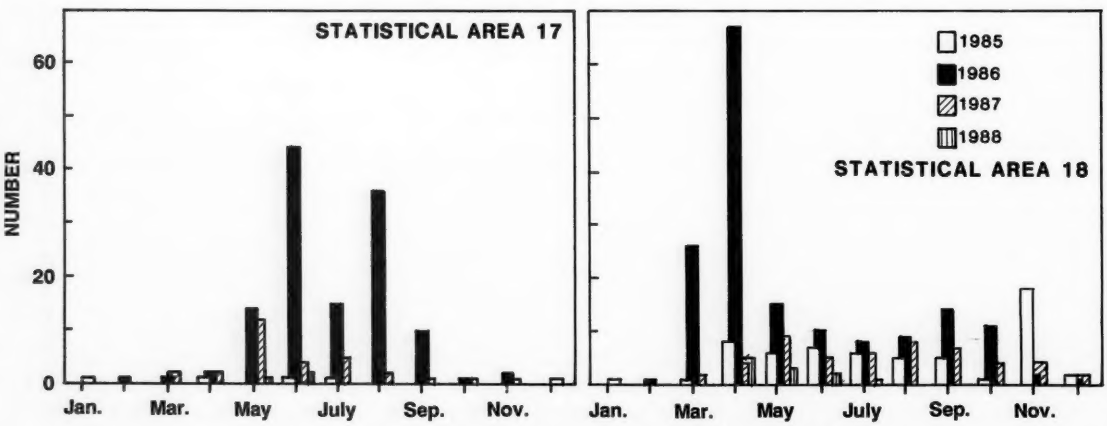

Figure 7.—Frequency of sea turtle strandings reported in Statistical Areas 17 and 18 from 1985 to 5 August 1988. Strandings in 1985 were reported by the public and confirmed by NMFS.

heads (4.2 and 5.5 kg) within 366 m, as well as one loggerhead (6.8 kg) at 915 m were rendered unconscious by a simultaneous explosion of four 23 kg charges. About 2 cm of the cloacal lining everted through the anal opening of the Kemp's ridley (6.7 kg) positioned at 229 m. Ridleys (1.3 and 1.5 kg) at distances of 549 and 915 m were apparently unharmed. Unconscious turtles recovered when removed from the cages. All loggerheads displayed abnormal pink coloration caused by dilated blood vessels at the base of the throat and flippers. This condition continued for about 3 weeks, after which time all turtles appeared normal. These data verified that explosions can result in both near- and far-field injuries to turtles (Table 3).

Supplementary data pertaining to fish were collected in conjunction with these experiments. Sheepshead, Atlantic croaker, *Micropoginias undulatus*; Atlantic bumper, *Chloroscombrus chrysurus*; Atlantic spadefish, *Chaetodipterus faber*; and black drum were found dead floating on the surface at the blast site. Necropsy of dead floating fish revealed internal damage ranging from minor tears in the gas bladder to severe lesions of abdominal organs (Guillen[3]). The same species were subsequently found dead on adjacent beaches. Twenty-nine of 99 drift bottles released at the platform were found in the same beach locality as the fishes within 2 days after the explosion indicating that surface currents probably were strongly directed toward shore. Three of 99 seabed drifters released at the platform were also recovered along the beach.

Review and Discussion

Relation of Strandings to Explosions

Dates and locations pertaining to the use of underwater explosives at offshore oil and gas structures are scattered throughout industry files. No government agency or agencies maintain a complete data base for explosives operations in offshore waters and coastal embayments. It would be a very long, arduous, and costly task to locate these records and compile them into an accurate and useful data base even with the cooperation of everyone involved. But compilation of these data is a prerequisite to comparing sea turtle strandings with the frequency and location of offshore explosions. Nevertheless, there is a striking relationship between the number of strandings which occurred during a period of high vs. low removal activity. Fifty-one turtle strandings occurred in Statistical Area 18 during 19 March-19 April 1986 following 22 nearshore explosions. Four and five strandings occurred during the same period in 1987 and 1988, respectively, when only 1 explosion was reported through July 1988. Thus, it appears that platform removals may have affected the strandings of turtles near Bolivar Peninsula. Although there is not such a striking relationship between the strandings of dolphins and explosive platform removals, more dolphins were found stranded in Statistical Area 18 during the 19 March-19 April time period in 1986, than in 1985, 1987, or 1988.

It is difficult to establish a connection between the stranding of an individual sea turtle and a particular offshore explosion. Turtles found on beaches are usually in such poor condition that it is

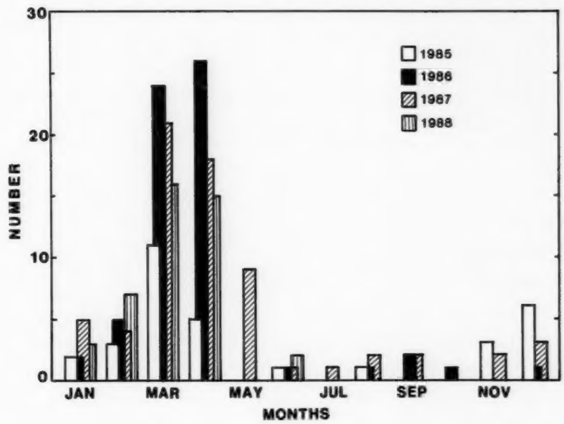

Figure 8.—Frequency of marine mammal strandings reported in Statistical Area 18 from 1985 to June 1988. Strandings in 1985 were reported by the public and confirmed by NMFS.

Table 3.—Description of turtle injuries with respect to distance from explosion and estimated energy level (dB) of shockwave.

Species	Distance from explosion (m)	Estimated energy level (dB)	Injuries: Immediate	Injuries: 1-hour post blast
Lepidochelys kempi	229	221	Unconscious	Vasodilation around throat and flippers; 2 cm of cloaca everted; vasodilation lasted 2-3 weeks.
Caretta caretta	229	221	Unconscious	Vasodilation around throat and flippers; redness around eye and nose; vasodilation lasted 2-3 weeks.
L. kempi	366	217	Unconscious	Appeared normal.
C. caretta	366	217	Unconscious	Normal behavior, but vasodilation present around base of flippers; vasodilation lasted 2-3 weeks.
L. kempi	549	213	None visible	Appeared normal.
C. caretta	549	213	None visible	Appeared normal except for vasodilation around throat and flippers; vasodilation lasted 2-3 weeks.
L. kempi	915	209	None visible	Appeared normal.
C. caretta	915	209	Unconscious	Appeared normal except for vasodilation around throat and flippers; vasodilation lasted 2-3 weeks.

[3]George Guillen, Texas Parks and Wildlife Department, P.O. Box 8, Seabrook, TX 77586. Personal commun.

impossible to determine cause of death even with a necropsy. Dead sea turtles generally sink until decomposition gases float the carcass to the surface 2-3 days later. Consequently, movement of a carcass may not correspond with that of drift cards released after an underwater explosion. Similarly, it is difficult, using surface observations, to document dead turtles immediately after an underwater explosion. A fresh sea turtle carcass placed 3.6 km off the coast of the southeastern United States took 13 days to wash ashore (Murphy[4]). Depending on the magnitude and direction of winds and currents, dead turtles may take weeks to wash ashore. The greater the distance from shore at time of death, the less likely the carcass will reach the beach. In addition, injured turtles are less able to avoid predators or may swim for undetermined distances and times before succumbing to injuries. Murphy[4] also observed sharks feeding on turtle carcasses at sea. Thus, an absence of stranded turtles on the beach is not conclusive evidence that turtles were not injured by offshore explosions.

Relation of Shrimping Effort to Strandings

An increase in turtle strandings did not correspond with an increase in shrimp fishing effort. In Statistical Area 18 strandings were high during March-April 1986. However, shrimping effort in <18 m depths was low during March and April 1985, 1986, 1987, and 1988 (39-388 vessel-days fished, 136-334 days, 107-248 days, and 48-113 days, respectively) while fishing effort was much higher in summer and fall months of June through November (291-1,400 vessel-days fished, 233-702 days, 504-2,350 days, and 457 days through April 1988, respectively).

Turtle strandings increased along the Atlantic coast when the shrimp season opened and fishing effort was high (Murphy[4]). However, low shrimping effort can result in a high incidence of turtle capture and subsequent death in areas where sea turtle density is high. Ogren[5] suggests that the high number of reported captures of juvenile Kemp's ridleys by shrimpers in the mid-1970's may be correlated with high densities of portunid crabs, a primary food source of the Kemp's ridley turtle.

Effects of Explosions

Information about the effects of underwater explosions on sea turtles is extremely limited. O'Keeffe and Young (1984) describe a series of three underwater shock tests conducted by the Naval Coastal Systems Center near Panama City, Fla., in 1981. Despite helicopter surveys for turtles prior to each of three detonations of 544 kg of TNT (Trinitrotoluene) at mid-depth in water about 37 m deep, at least three turtles were found after the explosions. One turtle was killed at a distance of 152-213 m; one turtle at 366 m sustained minor injuries; and one turtle at 610 m appeared to be uninjured. In the absence of other information, O'Keeffe and Young (1984) estimated a safe range of at least 79 m per cube root of turtle weight in kilograms for a 545 kg charge of TNT. O'Keeffe and Young (1984) assumed that shock waves injured the lungs and other organs which contained gas as is known to occur in birds and mammals. Researchers also expected the ear drums of turtles to be sensitive, and smaller turtles to suffer greater injuries from the shock wave than larger turtles.

The above method can be applied to our experiment in which two turtles were placed at each of four distances from an explosion. This yields a predicted safe range beyond 98 m for the smallest turtle (0.59 kg) and a safe range beyond 42 m for the largest turtle (6.82 kg). Predicted ranges assume a 544 kg explosion, although the actual weight totalled only 92 kg. The data show four turtles were rendered unconscious between 229 and 366 m from the detonation. One of these sustained damage to the cloacal lining at 229 m. Another turtle was also rendered unconscious at a distance of 915 m. In this case, the model developed by O'Keeffe and Young (1984) using 544 kg of explosive failed to predict a safe range for turtles.

Experimental animals were revived during the handling required to assess their physical condition. However, in the wild, unconsciousness will render a turtle more susceptible to predation, and the unconscious turtle may sink to the bottom. Although resting turtles can remain submerged for several hours, the effects of submergence on stunned turtles is unknown.

Little information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984). Research conducted at the Lovelace Biomedical and Environmental Research Institute on the impacts of underwater explosions on dogs, sheep, and monkeys showed similarities between species for reponse to shock waves as a function of specimen size. Two types of injuries resulted from underwater explosions: Hemorrhaging in and around the lungs and excitation of radial oscillations of small gas bubbles normally present in the intestine (Richmond et al., 1973; Yelverton et al., 1973).

Goertner (1982) developed a computer model to predict distances at which marine mammals exposed to underwater explosions would sustain injuries. The model estimated that an Atlantic bottlenose dolphin calf would suffer slight injury at about 1,189 m from a 544 kg charge of TNT detonated at 38 m in deep water. O'Keeffe and Young (1984) suggested doubling this estimate to provide an adequate margin of safety. Though currently unavailable, models should be developed specifically for sea turtles, and should address conditions encountered in platform removal operations. The magnitude of the impact zone will vary from site to site due to the weight and position (inside or outside piling; above or below mudline) of explosives, water depth, reflectivity of the bottom substrate, and reflectivity of density gradients within the water column. Therefore, existing models require refinement before they can be used with a high degree of confidence to predict safe ranges for turtles.

Since fish aggregate around offshore platforms (Shinn, 1974; Hastings et al., 1976; Jackson et al., 1978; Gallaway and

[4]Sally Murphy, South Carolina Wildlife and Marine Resources Department, P.O. Box 12599, Charleston, SC 29412. Personal commun.

[5]Larry H. Ogren. The biology and ecology of juvenile sea turtles: Kemp's ridley (*Lepidochelys kempi*) in the Gulf of Mexico and the north Atlantic. Unpubl. manuscr.

Martin, 1980; Gallaway and Lewbel, 1982; Tennison, 1985), probably for protection and food, similar factors may operate for sea turtles. Are sea turtles regularly associated with offshore energy structures, or is it only a chance event that turtles may be in the vicinity of a structure when underwater explosives are used?

Data collected at all structure removal sites monitored by NMFS observers from 5 April 1986 through 5 August 1988 show a total of 11 turtle sightings at 7 of 52 structures. Three of these turtles were seen at a single platform in July 1986 by Tim Fontaine[6] who observed them at night apparently feeding on juvenile blue crab, *Callinectes sapidus*, and rock shrimp, *Sicyonia brevirostris*).

A number of turtles have been observed in the vicinity of oil and gas structures in Gulf of Mexico waters off the Texas and Louisiana coasts. Lohoefener[7] reports sighting over 200 turtles during aerial surveys, many in areas characterized by high concentrations of oil platforms. Although the aerial surveys are limited in geographic scope, the information collected to date indicates specific oil platforms where sea turtles have been observed in the northern Gulf of Mexico. Fuller and Tappan (1986) reported two turtles observed by divers at Louisiana oil platforms. One of these, a leatherback, *Dermochelys coriacea*, apparently became entangled under the platform and died. We assume these structures provide a resting place or a location where food is readily available. Diving clubs have reported 27 underwater observations of sea turtles in the northwestern Gulf of Mexico through August 1987. Nine of these were associated with Texas oil platforms (Manzella[8]).

Eight scientific studies conducted in the Gulf of Mexico between 1975 and 1985 offer insights on the distribution and behavior of turtles around natural and artificial reef structures, although the studies did not focus on sea turtles (Rosman et al., 1987). Based entirely on observations by divers, submersibles, and time-lapse photography, underwater sightings of turtles were infrequent. Photographs often showed turtles lying on the sea floor within the confines of the camera assembly. More turtles were photographed at night than during the day. Successive photos suggested that turtles might remain within 3 m of the camera assembly for more than 2-3 hours. One individual loggerhead, identifiable by barnacle patterns on the shell, was seen at the West Flower Garden Bank in the Gulf of Mexico by scuba divers in February, June, and September of 1980. Rosman et al. (1987) suggested the superiority of time-lapse photography over diver observations based on 231 turtle sightings in 25,186 photographs versus 1 sighting in 77 dives in the southwest Florida study.

At the Buccaneer Platform off Galveston, Tex., 4 sightings were reported during 527 research dives between August 1977 and September 1980 (Rosman et al., 1987). Two of the four turtles were lying on the sea bottom in physical contact with the structure. The number of sightings may represent a minimum number of turtles in the area because the attention of divers was not focused on turtles. In a similar situation on 20 August 1987, Gitschlag conducted a task-oriented dive at Buccaneer without sighting a turtle, although Renaud observed one turtle twice within 20 minutes from a dive boat at the surface.

Further evidence that turtles are found around other man-made structures comes from studies at the Florida Power and Light Company's St. Lucie Plant. Between 1976 and 1986, 1,530 sea turtles were entrained through three cooling water inlet pipes (3.7-4.9 m diameter) located 365 m offshore. The species composition of turtles included 86 percent loggerhead, 13 percent green, and about 1 percent leatherback, Kemp's ridley, and hawksbill, *Eretomochelys imbricata*, combined (Florida Power and Light, 1986).

The above data show that turtles are found in the vicinity of offshore structures. However, observation and capture of two loggerhead turtles by NMFS in August 1988 at offshore platforms suggest that loggerhead turtles hide and/or rest on the bottom under these structures. The nature of these associations merit further investigation. Quantification of resident vs. transient turtles, distance at which resident turtles may range from structures, and seasonal abundance in various geographic areas are just a few of the questions which remain to be answered.

It is interesting to note a difference in regulations for installation vs. removal of offshore oil and gas structures. Extensive environmental impact statements are prerequisite to installation of offshore structures. In contrast, prior to 1986 no formal environmental monitoring was required for structure removal, despite the fact that these structures represent more hard substrate habitat than occurs in all the natural reef and hard bank areas off the Louisiana coast (Reggio et al., 1986). If recent estimates are correct, between 1,600 and 2,000 offshore oil and gas structures are to be removed from the Gulf of Mexico by the end of the century. This raises serious questions about the impacts not only of explosives but also of the potential loss of valuable habitat to a wide variety of marine life.

While it is important to continue monitoring the biological impacts of explosive offshore removals, it is also necessary to develop methods to disperse protected marine life from removal sites prior to detonating explosives. Standard procedures could then be implemented to minimize impacts to turtles and dolphins while simultaneously reducing the delays presently affecting the structure removal process.

Conclusions

Although sea turtles and dolphins are found at offshore energy structures, the details of this association have not been thoroughly investigated. No cause and effect relationship between turtle and dolphin mortalities and offshore explosions has been documented because no dead animals have been recovered at removal sites. Fish were killed at all removal sites monitored by NMFS per-

[6]Tim Fontaine, NMFS Galveston Laboratory, 4700 Avenue U, Galveston, TX 77551. Personal commun.

[7]Ren Lohoefener, NMFS Pascagoula Laboratory, 3209 Fredric Str., Pascagoula, MS 39567. Personal commun.

[8]Sharon Manzella, NMFS Galveston Laboratory, 4700 Avenue U, Galveston, TX 77551. Personal commun.

sonnel. Experimentally exposed turtles and, consequently, wild turtles can be injured by underwater explosions. Comparison of turtle stranding data during periods characterized by high and low numbers of offshore explosions suggests a connection between explosions and the number of turtle strandings; data are less supportive of a relationship between explosions and dolphin strandings. The high number of dead turtles stranded in close proximity to nearshore structure removals provides circumstantial evidence that at least some may have been killed by underwater explosions. However, it is apparent that other factors, including capture in shrimp trawls, ingestion of plastic refuse, and entanglement in debris, are also responsible for turtle mortalities.

Acknowledgments

We acknowledge the assistance of Marcel Duronslet for providing information on NMFS beach stranding effort and turtle stranding data. Dennis Koi prepared computer graphic representations of the data. The Texas Marine Mammals Stranding Network supplied information on marine mammal strandings.

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National Marine Fisheries Service Habitat Conservation Efforts in the Coastal Southeastern United States for 1987

ANDREAS MAGER, Jr., and RICKEY RUEBSAMEN

Introduction

The coastal southeastern region of the United States covered by the National Marine Fisheries Service (NMFS) includes eight states from North Carolina to Texas and Puerto Rico and the U.S. Virgin Islands, along with the territorial seas and the Exclusive Economic Zone out to 200 miles. The region contains 2,799 miles of coastline with 29,900 miles of tidal shoreline, or about 56 percent and 54 percent, respectively, of the total coastline and shoreline of the contiguous United States (Shalowitz, 1964; Orlando et al., 1988).

ABSTRACT—Data quantifying the cumulative acreage of coastal habitat affected by Corps of Engineers (COE) programs that regulate development in wetlands of the southeastern United States are provided for 1987. The National Marine Fisheries Service (NMFS), Southeast Region, made recommendations on 4,713 water development proposals submitted by or to the COE. Of these, 1,054 proposed to alter 21,756 acres of fishery habitat through 3,506 acres of dredging, 2,899 acres of filling, 1,303 acres of draining, and 14,048 acres of impounding. The NMFS did not object to alteration of 8,135 acres and recommended the conservation of 13,621 acres. To offset habitat losses, 7,139 acres of mitigation were recommended by NMFS or proposed by applicants and/or the COE. Of the wetland alterations accepted by NMFS, nearly 5,000 acres involved impounding for marsh management in Louisiana. A follow-up survey of 266 permits issued by the COE during 1987 revealed that only 46 percent of NMFS recommendations were accepted by the COE. On a permit by permit basis, 25 percent of NMFS recommendations were partially accepted, 21 percent were completely rejected, and 8 percent were withdrawn.

The more than 300 estuarine systems located in the southeast contain about 17.2 million acres of marsh and other estuarine habitat (Lindall and Thayer, 1982) and 5.1 million acres of intertidal areas (de la Cruz, 1981). The region's coastal wetlands comprise about 83 percent of the coastal wetlands in the coterminous United States; 46 percent for the Gulf of Mexico and 37 percent for the South Atlantic area (Alexander et al., 1986). The region contains all of the nation's mangrove swamp wetlands, which total between 400,000 and 650,000 acres (Odum et al., 1982). Most of the nation's seagrasses also are located in the southeast region. These vital wetlands are seldom included in wetland surveys because of the difficulty in mapping them. These remaining seagrasses could increase current wetland acreage in the region by at least 40 percent (Thayer and Fonseca[1]).

It is the general consensus of estuarine fisheries scientists that about 96 percent of commercial and 70 percent of recreational fishery resources in the southeast are estuarine dependent. During 1987, about 2.8 billion pounds of fish and shellfish, excluding Puerto Rico and the U.S. Virgin Islands, were commercially harvested from estuarine and marine habitats of the region (NMFS, 1988). These resources were worth about $850 million at dockside, but may generate at least three times this value as the product moves through processing stages and wholesale and retail markets. The combined harvest of fish and shellfish in the region represents 41 percent of the amount and 28 percent of the value of the fishery resources taken in the United States. Recreational fisheries information is available only for 1985 and earlier. However, during 1985, 11 million recreational fishermen caught about 222 million fish in the southeast (Schmied and Burgess, 1987). That year the southeast also accounted for over 40 percent of the nation's saltwater anglers, 62 percent of all trips, 50 percent of the catch by number of fish, and over 55 percent ($3.4 billion) of all direct expenditures made nationally by saltwater anglers (Schmied and Burgess, 1987).

The importance of wetlands and their role in providing habitat for fish and shellfish are well documented (Smith et al., 1966; Douglas and Stroud, 1971; Lindall, 1973; Turner, 1977; Lindall and Saloman, 1977; Peters et al., 1979; Thayer and Ustach, 1981). Despite their great importance, coastal wetlands are being lost at an alarming rate (Tiner, 1977; 1984). Alexander et al. (1986) reported that based on data in Frayer et al. (1983), for the last 25 years, coastal

[1]Thayer, G. W., and M. S. Fonseca. 1988. Beaufort Laboratory, Southeast Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, N.C. Personal commun.

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wetlands have been depleted at an average annual rate of 20,000 acres. The loss of coastal wetlands is probably greater in the southeast than elsewhere in the United States. Hefner and Brown (1985) determined that in this region these losses accounted for 84 percent of the wetland losses nationwide and this does not include losses to seagrass systems for which there is no documentation. An example is the conversion to open water of about 50 square miles of marsh per year in Louisiana (Turner, 1987).

Wetland loss or change occurs from a variety of natural and man-induced factors. Natural forces such as sea level rise, erosion, subsidence, and hydrologic changes can have a dramatic effect on wetlands, such as converting marsh to open water. Water development (e.g., construction of oil and gas access canals) also alters considerable amounts of coastal wetlands (Lindall et al., 1979). Indirect impacts of canals and spoil banks may be far more important than their direct effects (Scaife et al. 1983). Estimates of shoreline modification, dredged channels, and dredged material disposal areas in 92 of the nation's estuaries were prepared by Orlando et al. (1988). The 46 estuaries (out of 300) surveyed in the southeast comprise a surface area of about 14,500 square miles at mean low water with a shoreline of about 24,000 miles total. About 1,300 miles of the shoreline have been modified, almost 2,000 miles of navigation channels have been built, and resulting dredged material disposal areas cover nearly 300 square miles of surface area.

In view of the importance of fisheries in the southeast and the nation as a whole, the need to actively conserve wetlands and deepwater habitats is paramount. Boesch and Turner (1984) emphasize that the key to fishery management of estuarine dependent species is coastal habitat protection and enhancement. Since NMFS is the lead Federal agency responsible for the management of our nation's living marine resources, the conservation of habitat that supports these resources is of prime importance to the agency. This responsibility is carried out by the Habitat Conservation Division (HCD), and a description of the HCD and its operations are presented by Lindall and Thayer (1982) and Mager and Thayer (1986).

The HCD has determined from habitat conservation efforts in the southeast since 1981, that direct involvement with the wetland regulatory and civil works programs of the Corps of Engineers (COE) and with other Federal agencies results in significant conservation of fisheries habitat (Lindall and Thayer, 1982; Mager and Thayer, 1986; Mager and Keppner, 1987; Mager and Hardy, 1988). The data in these reports are needed for assessing the cumulative effects of fishery habitat alterations and to determine where the NMFS habitat conservation efforts should best be directed. This paper contains the results of NMFS' 1987 habitat conservation efforts and builds on earlier reports. We recognize that the largely unquantified efforts of other state and federal natural resource agencies also play vital roles in the conservation of wetlands.

Materials and Methods

Lindall and Thayer (1982) and Mager and Thayer (1986) described the methods involved in gathering and structuring the data reported herein. Our data base contains information on the kind of project requested, its location, NMFS recommendations, kind and extent of proposed wetland alterations, and the area of impact the NMFS did not object to. Mitigation acreage also is recorded. These data provide a measure of potential cumulative wetland losses and gains as well as wetlands potentially conserved. The acreage values presented for the projects surveyed for 1987 were obtained from onsite reviews by NMFS contractors or NMFS biologists, from public notices, and from project plans where these were adequate to determine the acreage and habitat types proposed for alteration. Out of the 4,173 projects reviewed, 1,054 were used for our detailed analyses because sufficient information was available to determine accurately the area and type of wetlands requested for alteration. Data are stored on an NBI OASys 64[2] computer with 120 megabytes of storage and entered using an NBI 2000 workstation. The results presented were obtained using the DBASE II database management system.

Results

The Southeast Region reviewed 56 percent of all permit requests reviewed by the NMFS throughout the United States in 1987. The NMFS evaluated and responded to 7,378 proposals nationwide for construction in wetlands and 4,173 of these were in the southeastern coastal states. Of the projects reviewed in the southeast, 2,861 (68.6 percent) received a "no objection" response because impacts on fishery habitat were perceived to be minimal or overcome through appropriate mitigation, the projects were inland, or no fishery resources under the purview of the NMFS were present. The last category amounted to 822 projects. In-depth review was given to 1,303 (31.2 percent) of the projects because probable adverse effects to fishery resources would be significant. Nine projects (0.2 percent) were not evaluated because they were in offshore areas where the COE accepts only comments pertaining to navigation or national defense.

The permit requests included the following types and number of projects: Shoreline alterations such as bulkheads, small fills, groins, and ramps (806); docks and other minor structures (740); housing developments (490); maintenance dredging (414); oil and gas exploration (373); navigation channels and marinas (251); industrial and commercial development (219); bridges and causeways (219); water, gas, and chemical pipelines (170); barriers, dams, and impoundments (158); miscellaneous activities (139); irrigation (66); sand, gravel, and other mining (63); electrical transmission lines (38); beach nourishment (22); and electric generating facilities (5).

Activities undertaken by NMFS in regard to these projects are summarized in Table 1 which lists the state, the num-

[2]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Number of proposed projects and acres of habitat by state involved in NMFS habitat conservation efforts for 1987. Numbers in parentheses refer to columns discussed in text.

State	No. of permit applications (1)	Acreage proposed by applicants: Dredge (2)	Fill (3)	Drain (4)	Impound (5)	Acreage NMFS accepted or did not object to: Dredge (6)	Fill (7)	Drain (8)	Impound (9)	Potential acreage conserved: Dredge (10)	Fill (11)	Drain (12)	Impound (13)	Mitigation recommended by NMFS: Restore acreage (14)	Generate acreage (15)	Enhance acreage (16)
TX	91	526.3	495.0	0	2.5	429.0	133.0	0	2.0	97.3	362.0	0	0.5	27.0	197.0	42.2
LA	86	548.4	740.2	1,303.0	13,439.4	244.5	284.1	0	4,737.2	303.9	456.1	1,303.0	8,702.2	198.2	60.5	6,148.0
MS	14	166.6	107.5	0	0	22.1	0.1	0	0	144.5	107.4	0	0	0.5	4.4	0
AL	24	200.7	86.8	0	0.7	115.1	29.4	0	0	85.6	57.3	0	0.7	110.0	28.7	0
FL	380	342.1	663.3	0	0.1	139.3	168.1	0	0.1	202.8	495.3	0	0	59.1	61.0	36.7
GA	66	408.5	127.5	0	0	121.3	58.9	0	0	287.2	68.6	0	0	7.2	111.1	0
SC	147	135.7	144.2	0	561.6	107.1	73.7	0	0	28.6	70.5	0	561.6	10.2	3.3	0
NC	236	1,013.8	462.4	0	43.6	986.5	440.8	0	40.0	27.3	21.6	0	3.6	5.2	28.5	0
PR	5	101.3	47.5	0	0	1.3	1.0	0	0	100.0	46.5	0	0	0	0	0
VI	5	62.2	24.2	0	0	0	0	0	0	62.2	24.2	0	0	0	0	0
Total	1,054	3,505.6	2,898.6	1,303.0	14,047.9	2,166.2	1,189.1	0	4,779.3	1,339.4	1,709.5	1,303.0	9,268.6	417.4	494.5	6,226.9

ber of permit applications where NMFS was able to obtain accurate information on area of impact, and habitat acreage involved in dredging, filling, draining, and impounding. Habitat types proposed for alteration appear in Table 2. A survey of alterations by various types of projects tracked is summarized in Table 3. Quantification of these data for the southeastern coastal states follows.

Dredging

During 1987, 3,506 acres of wetlands were proposed for dredging (Table 1, column 2). Of this total, 29 percent of all dredging was in North Carolina, 15 percent each in both Louisiana and in Texas, 11 percent in Georgia, 10 percent in Florida, 6 percent in Alabama, 5 percent in Mississippi, 4 percent in South Carolina, 3 percent in Puerto Rico, and 2 percent in the U.S. Virgin Islands. The NMFS did not object to the dredging of 2,166 acres (Table 1, column 6), but did recommend that 1,339 acres of habitat important to fishery resources not be dredged (Table 1, column 10).

Vegetated wetlands proposed for dredging totaled 605 acres, while unvegetated substrates totaled 2,900 acres. Maintenance and new dredging of existing navigation channels accounted for 1,669 acres (77 percent) of the dredging activities not objected to by NMFS (Table 3, column 6). The NMFS did not recommend against the dredging of 130 acres of vegetated wetlands, but most of this acreage was in freshwater areas that we felt did not support marine, estuarine, or anadromous fishery resources.

Table 2.—Acres of habitat, by habitat type, involved in NMFS habitat conservation efforts during 1987 (based on 1,054 projects sampled).

Habitat type	Proposed for alteration	Accepted by NMFS	Potentially conserved	Requested for mitigation
Red mangrove	35.2	0.2	35.0	40.5
White mangrove	238.5	0.9	237.6	2.1
Black mangrove	134.2	4.2	130.0	1.0
Smooth cordgrass	3,220.9	40.0	3,180.9	156.5
Black needlerush	46.3	10.4	35.9	7.8
Saltmeadow cordgrass	3,317.1	2,184.1	1,133.0	2,612.2
Saltgrass	16.2	1.0	15.2	3.9
Threecorner grass	175.7	0	175.7	0.4
Other marsh	533.9	335.7	198.2	499.0
Shoalgrass	9.0	8.6	0.4	8.7
Widgeongrass	1,952.9	1,850.2	102.7	1,831.8
Manateegrass	0.2	0	0.2	0
Turtlegrass	63.6	1.0	62.6	0.1
Eelgrass	2.8	0	2.8	0
Halophila	0.1	0	0.1	0
Algae	11.9	0.2	11.7	0
Hardwood swamp	4,399.1	135.1	4,264.0	114.4
Freshwater wetlands	1,200.9	140.8	1,060.1	200.2
Unvegetated wetlands	6,333.9	3,373.9	2,960.0	1,650.2
Oyster beds	0.2	0	0.2	0.2
Miscellaneous	62.5	48.3	14.2	9.8
Total	21,755.1	8,134.6	13,620.5	7,138.8

Filling

Over 2,899 acres of wetlands were proposed for filling (Table 1, column 3). More than 25 percent of the total was in Louisiana, followed by Florida (23 percent), Texas (17 percent), North Carolina (16 percent), South Carolina (5 percent), Mississippi and Georgia (4 percent each), Alabama (3 percent), Puerto Rico (2 percent), and the U.S. Virgin Islands (1 percent). While we did not object to the filling of 1,189 acres (Tables 1 and 3, column 7), we did recommend conservation of 1,710 acres (Tables 1 and 3, column 11).

The acreage proposed for filling during 1987 included 1,530 acres of vegetated wetlands and 1,369 acres of unvegetated bay bottom. The NMFS did not oppose filling of 316 acres of vegetated and 873 acres of unvegetated wetlands. These wetlands mainly were in

Table 3.—Number of proposed projects and acres of habitat by project type involved in NMFS habitat conservation efforts for 1987. Numbers in parentheses refer to columns discussed in text.

Project type[1]	No. of permit applications (1)	Acreage proposed by applicants Dredge (2)	Fill (3)	Drain (4)	Impound (5)	Acreage NMFS accepted or did not object to Dredge (6)	Fill (7)	Drain (8)	Impound (9)	Potential acreage conserved Dredge (10)	Fill (11)	Drain (12)	Impound (13)	Mitigation recommended by NMFS Restore acreage (14)	Generate acreage (15)	Enhance acreage (16)
SH	276	19.8	71.4	0	0.1	10.9	11.5	0	0.1	8.9	59.9	0	0	3.0	17.4	0
HO	234	150.7	574.3	933.0	2,468.7	17.6	93.1	0	0	133.1	481.2	933.0	2,468.7	33.2	22.8	21.7
NA	115	1,077.8	577.4	0	0	536.8	135.2	0	0	541.0	442.2	0	0	5.5	275.0	38.0
MD	107	1,315.4	512.4	0	0	1,132.7	328.9	0	0	182.7	183.5	0	0	120.1	8.6	0
BR	84	31.4	110.8	0	0	28.5	72.9	0	0	2.9	37.9	0	0	2.0	58.9	4.2
IN	82	231.2	309.8	0	1.1	84.9	57.1	0	0	146.3	252.7	0	1.1	30.4	39.4	15.0
OI	44	302.0	278.2	0	67.7	218.3	120.9	0	2.0	83.7	157.3	0	65.7	184.4	24.6	44.0
BA	35	94.6	79.9	370.0	11,510.3	60.0	33.9	0	4,777.2	34.6	46.0	370.0	6,733.1	15.5	16.9	6,104.0
OT	25	101.1	49.7	0	0	1.3	21.9	0	0	99.8	27.8	0	0	2.5	17.9	0
IR	22	10.5	11.2	0	0	3.9	6.0	0	0	6.6	5.2	0	0	2.2	8.5	0
BE	11	99.5	310.5	0	0	42.6	304.5	0	0	56.9	6.0	0	0	0.1	0.1	0
PI	11	5.5	3.4	0	0	5.1	2.2	0	0	0.4	1.2	0	0	7.5	0	0
TR	4	18.1	1.1	0	0	18.1	1.0	0	0	0	0.1	0	0	0	4.4	0
MI	3	38.0	1.3	0	0	0	0	0	0	38.0	1.3	0	0	0	0	0
EL	1	10.0	7.2	0	0	5.5	0	0	0	4.5	7.2	0	0	11.0	0	0
Total	1,054	3,505.6	2,898.6	1,303.0	14,047.9	2,166.2	1,189.1	0	4,779.3	1,339.4	1,709.5	1,303.0	9,268.6	417.4	494.5	6,226.9

[1](SH) bulkheads, small fills, groins, etc.; (HO) housing developments; (NA) navigation projects, marinas, etc.; (MD) maintenance dredging; (BR) bridges, roads, and causeways; (IN) commercial and industrial development; (OI) oil and gas construction; (BA) barriers, impoundments, and marsh management areas; (OT) unclassified; (IR) irrigation and drainage works; (BE) beach nourishment projects; (PI) oil, gas, and chemical pipelines; (TR) transmission lines; (MI) mining and mineral exploration; and (EL) electric plants.

freshwater areas that did not contain fishery resources under NMFS purview. More than 92 percent of the proposed filling (2,673 acres) was involved in activities related to construction for navigation projects, housing developments, maintenance dredging, beach nourishment, industrial and commercial development, oil and gas development, and bridges and causeways (Table 3, column 3).

Draining and Impounding

The NMFS recommended against the proposed draining for residential development of 1,303 acres of wooded swamp in Louisiana (Table 1, column 4). Impounding of 14,048 acres of coastal wetlands also was proposed (Table 1, column 5). The NMFS did not object to the impounding of 4,737 acres for marsh management in Louisiana (Table 1, column 9). This acreage was largely contained in two projects, one of which was previously impounded and for which management would allow drawdown to stimulate germination of marsh vegetation and provide some fishery utilization. The other project involved an area that was heavily impacted by subsidence, erosion, and saltwater intrusion. For this latter project, NMFS agreed to limited management, provided that access by fish and shellfish to the site was maintained. In agreeing to such marsh impoundments, NMFS seeks to ensure continued or increased access by fishery resources which use the sites for feeding and maturation.

Of the 9,269 acres of proposed impounding that NMFS recommended against (Table 1, column 13), it was probable that impoundment would not maintain or enhance wetlands or there would be significant loss of use by marine and estuarine organisms. Almost 2,500 acres of this total was intended as a marsh management area to mitigate for the adverse environmental impact of one proposed housing development in Louisiana (Table 3, column 5).

Mitigation

If projects are determined by the NMFS to be water dependent (i.e., require immediate water use or access to achieve their purpose), in the public interest, and the habitat losses are unavoidable, then NMFS may recommend that resulting losses be mitigated to the "maximum extent practicable" (Lindall et al., 1979). Typical examples include navigation projects and restoration of unauthorized activities that may significantly alter fisheries habitat. In many cases wetlands which must be only temporarily altered are recommended for restoration when their use is no longer needed. A conservative approach to mitigation is taken because the technology is still experimental; there is no guarantee that man-made wetlands will persist as permanent substitutes for sacrificed natural habitats; and we do not know whether artificial habitats produce fishery resources to the same extent as natural habitats. Coastal managers must be more specific about project requirements and goals before approval for mitigation is granted and continued research on a regional basis is needed to advance marsh establishment techniques into a proven technology (Race, 1985).

We categorized mitigation projects into three categories: Restore, generate, and enhance. The "Restore" category is represented by projects such as pipeline trenches, temporary roadways, temporary borrow areas, and in some cases the restoration of access channels for abandoned oil and gas wells (Table 3, column 14). The "Generate" category was only used when new wetlands would be created (Table 3, column 15). The "Enhance" category (Table 3, col-

Table 4.—Acres of habitat alterations involved in NMFS habitat conservation efforts between 1981-87.

Year	No.[1]	Acres proposed	Acres accepted by NMFS	Acres conserved	Acres mitigated
1981	811	7,949	2,868	5,081	2,471
1982	1,059	81,184	21,831	59,353	7,910
1983	825	20,778	8,658	12,120	26,775
1984	888	8,606	3,981	4,625	54,050
1985	1,802	65,670	11,161	54,509	19,200
1986	969	90,559	70,838	19,721	49,713
1987	1,054	21,755	8,135	13,620	7,139
Total	7,408	296,501	127,472	169,029	167,258

[1]Number of projects sampled.

Table 5.—Treatment of NMFS recommendations on permits issued by Corps of Engineers (COE) District for 1987. Values in parentheses represent percent of number of permits sampled for each category.

COE district	No.[1]	NMFS recommendations accepted	NMFS recommendations partially accepted	NMFS recommendations rejected	Applications withdrawn
Wilmington	7	7 (100.0)	0	0	0
Savannah	7	6 (85.7)	0	1 (14.3)	0
Charleston	26	21 (80.8)	2 (7.7)	3 (11.5)	0
Galveston	78	43 (55.1)	11 (14.1)	5 (6.4)	19 (24.4)
Mobile	22	11 (50.0)	5 (22.7)	6 (27.3)	0
New Orleans	49	17 (34.7)	18 (36.7)	11 (22.5)	3 (6.1)
Jacksonville	77	16 (20.8)	31 (40.2)	30 (40.0)	0
Total	266	121 (45.5)	67 (25.2)	56 (21.0)	22 (8.3)

[1]Number of permits sampled.

umn 16) was used primarily for marsh management areas when benefits to fisheries could clearly be demonstrated or for minor activities (e.g., oil well canal plugs) that prevent erosion or salt water intrusion or reestablish preproject hydrologic patterns.

During 1987, NMFS' Southeast Region recommended or accepted 417 acres of restoration (Table 1, column 14), 494 acres of habitat generation (Table 1, column 15), and 6,227 acres of wetland enhancement (Table 1, column 16). The greatest amount of mitigation sought was for enhancement of saltmeadow cordgrass marshes and widgeongrass beds (Table 2).

Cumulative Totals

Overall, about 21,755 acres of coastal wetlands (Table 1, columns 2+3+4+5) were proposed for alteration during 1987. The NMFS accepted or did not object to the alteration of 8,135 acres (Table 1, columns 6+7+8+9) and potentially conserved 13,621 acres (Table 1, columns 10+11+12+13). We use the term potentially because the COE may issue permits over our objections. The NMFS also recommended or accepted the restoration, generation, and enhancement of almost 7,139 acres (Table 1, column 14+15+16) to mitigate for adverse project impacts. Vegetated wetlands comprised 71 percent (15,389 acres) of the total area proposed for alteration; 58 percent (4,709 acres) of the area accepted for alteration by NMFS; 78 percent (10,680 acres) of the area potentially conserved; and 77 percent (5,496 acres) of the area of mitigation.

Between 1981 and 1986, more than 274,746 acres of wetlands were proposed for alteration by 6,354 water-development projects (Mager and Keppner, 1987). The addition of these 1987 data brings the total area proposed to 296,501 acres by 7,408 projects (Table 4). Based on the projects surveyed, the amount of wetlands accepted for alteration by NMFS, the amount potentially conserved, and the amount potentially mitigated total 127,472; 169,029; and 167,258 acres, respectively, for the 7 years we have collected such data. The variations in the amount of potential habitat losses encountered from year to year result mainly from large projects that are sporadically proposed. For example, the larger amount of proposed alterations observed during 1986 resulted mainly from one large maintenance dredging project (>20,000 acres) and several large marsh management areas. Favorable economic conditions also may result in an increased number of proposed projects.

Effect of NMFS Recommendations

We determined how our recommendations were treated by the COE based on a survey of 266 projects (Table 5). These projects were used for our analyses because we already had information in our data base to determine the amount and type of habitat that was proposed for alteration and was recommended for conservation by the NMFS. We also had copies of the issued permits to compare what had been approved by the COE. These permits all were issued during 1987, but because of the length of the review process and other factors the initial public advertisement of the work and the NMFS review may have occurred in previous years.

The overall acceptance of NMFS recommendations, as determined by their incorporation in issued COE permits, was 46 percent. NMFS recommendations were partially accepted and completely rejected 25 percent and 21 percent of the time, respectively. Applications were withdrawn by applicants for 22 (8 percent) of the projects surveyed. Table 5 ranks the COE Districts by their incorporation of NMFS habitat recommendations into issued permits. The District with the highest acceptance of NMFS recommendations was the Wilmington District (100 percent) followed by the Savannah District (85.7 percent), the Charleston District (80.8 percent), the Galveston District (55.1 percent), the Mobile District (50 percent), the New Orleans District (34.7 percent) and the Jacksonville District (20.8 percent). Based on the experiences of HCD biologists, the percentages of acceptance and partial acceptance appear to be more accurately a reflection of the decision of individual applicants to agree or partially agree to our recommendations rather than the COE's determination that applications should be

Table 6.—Acres of habitat permitted for alteration over NMFS objections during 1987 by Corps of Engineers (COE) district.

COE District	No.[1]	Acreage proposed by applicants	Acreage NMFS accepted or did not object to	Acreage COE permitted	Percent difference[2]	Acreage NMFS recommended mitigation	Acreage COE permitted mitigation
Wilmington	7	2.3	1.4 (60.9)[3]	1.4 (60.9)[3]	0	2.5	2.5
Savannah	7	17.2	10.8 (62.8)	10.9 (63.4)	0.6	93.7	93.7
New Orleans	49	7,486.6	6,982.4 (93.2)	7,142.6 (95.4)	2.2	6,880.2	6,915.7
Charleston	26	105.3	5.7 (5.4)	18.1 (17.1)	11.7	10.9	22.9
Galveston	78	2,588.0	427.2 (16.5)	793.3 (30.7)	14.2	292.5	367.1
Jacksonville	77	128.3	47.1 (36.7)	120.1 (93.6)	56.9	17.6	21.1
Mobile	22	295.3	41.1 (13.9)	283.1 (95.9)	82.0	4.4	16.6
Total	266	10,623.0	7,515.7 (70.7)	8,369.5 (78.8)	8.1	7,301.8	7,439.6

[1]Number of permits sampled.
[2]Percent difference column is percent habitat alterations accepted by NMFS subtracted from the percent permitted by the COE.
[3]Numbers in parentheses refer to percent of the acreage proposed.

revised or permits conditioned.

The 266 proposals surveyed proposed to alter 10,623 acres of estuarine fishery habitat. The NMFS did not oppose the alteration of 7,516 acres, but recommended that the remaining 3,107 acres be conserved (Table 6). Of this latter amount, the COE overrode NMFS objections and issued permits for the removal of 2,254 acres of coastal fisheries habitat. The Mobile District permitted 82 percent more alterations than recommended by NMFS, followed by the Jacksonville District (56.9 percent), Galveston District (14.2 percent), the Charleston District (11.7 percent), the New Orleans District (2.2 percent), the Savannah District (0.6 percent), and the Wilmington District (0 percent). Overall, the COE issued permits authorizing 8 percent more habitat alterations than recommended by NMFS. The variation observed in the way NMFS recommendations are treated among the COE districts may largely result from differences in the way fish and wildlife production and other wetland benefits are considered in the public interest review. This occurs because the COE districts are relatively autonomous (GAO, 1977). The public interest review determines whether or not a permit will be granted.

In 1987, 7,302 acres of mitigation were proposed or recommended to compensate for habitat lost through the permitting process. The COE incorporated 7,440 acres of mitigation into the issued permits. As previously noted, mitigation agreements not required by the COE often resulted from negotiations between NMFS biologists and permit applicants.

Overall acceptance, partial acceptance, and rejection of NMFS recommendations were 53 percent, 23 percent, and 24 percent, respectively, from 1981 to 1986, based on examination of 1,084 issued permits (Mager and Thayer, 1986; Mager and Keppner, 1987). This trend compares closely with what we observed during 1987. The acreages of wetlands permitted for alteration by the COE exceeded NMFS recommendations by 17 percent from 1981 to 1986 as opposed to 8 percent for 1987. Table 5 provides a better indication of how the various COE districts incorporate NMFS recommendations because many small projects that can cause cumulatively large wetland losses receive equal consideration with the larger projects.

The acreages in Table 6 can change considerably with the addition of individual large projects within a COE district. For example, during 1986 the Charleston District ranked second to the Wilmington District in acceptance of NMFS recommendations on a permit-by-permit basis (Mager and Keppner, 1987). However, when acreages permitted over NMFS recommendations were examined, the Charleston District permitted the greatest amount of wetland alterations against the recommendations of the NMFS. This resulted from the permitting of one large project involving the reimpoundment of 1,050 acres of wetlands (Mager and Keppner, 1987).

Discussion

The area of proposed habitat alterations we report represents primarily that which affects resources under the purview of NMFS. Programs of the Fish and Wildlife Service, the Environmental Protection Agency, and state and local wetland conservation agencies involve additional, but usually unquantified wetland acreages.

Among the COE districts, many general permits have been developed authorizing specific activities that the NMFS is presently unable to monitor. One such example is a general permit in Louisiana that authorizes a large number of activities including oil and gas exploration when only a drilling slip would need to be dredged. During 1987, more than 600 projects were authorized by this one general permit alone. While many of the activities covered by this permit would involve only minor work, nearly 4 acres of wetland alteration are allowed for each authorized drilling slip. Some of these oil and gas activities have recently come under a review process whereby NMFS can recommend impact reduction to less than the amount that would be authorized by the general permit.

Cumulative wetland losses were to be evaluated by the COE and resource agencies on an annual basis. However, we have not been provided the information necessary to conduct a cumulative impact assessment. Similar problems apply to the other general and nationwide permits utilized in the southeast.

Relating such activities to habitat conservation concerns is compounded by the COE delegating the administration of some of the general permits to local authorities.

The importance of conserving fishery habitat has long been recognized by resource agencies, but has received varying levels of attention by the regulatory agencies that permit wetland alterations. We are concerned that public interest determinations, which are required before authorization for a water development project is granted, often may not give sufficient weight to fisheries values associated with wetlands. These values, as well as the need to maintain fishery habitats, however, have been recognized by Congress through amendment of the Magnuson Fishery Conservation and Management Act (MFCMA).

The MFCMA's new consultation procedures appear to be the congressional response to ineffective habitat protection under existing legislation such as the Fish and Wildlife Coordination Act (Kennedy, 1988). The MFCMA gives the regional fishery management councils, including the three councils in the southeast, additional authority to conserve the habitat of fish and shellfish they manage. The Gulf of Mexico Fishery Management Council's area covers the Gulf of Mexico from Texas to Florida; the South Atlantic Fishery Management Council's area covers the eastern United States from North Carolina to Florida; and the Caribbean Fishery Management Council manages fisheries in waters around Puerto Rico and the U.S. Virgin Islands.

Specifically, the regional councils are expected to include habitat information in their fishery management plans and have been given authorization to comment on and recommend changes to Federal and state activities affecting fishery habitat (Kennedy, 1988). The action agencies also are required to respond to the councils within 45 days giving a detailed account on how their concerns were addressed. The three councils in the southeast have established policies and procedures to implement the habitat provisions in the MFCMA. We expect them to be important new partners in the NMFS habitat conservation efforts.

Conclusions

Data collected by NMFS continue to document the extent of potential wetland alterations affected by regulatory programs in the coastal southeast. In view of the cumulatively large amount of wetlands which would be altered through the COE permit process, we believe there is ample justification for some COE Districts to increase the rate at which they accept and incorporate NMFS and other resource agency recommendations into the public interest review process. The need for habitat conservation programs to manage living marine resources is demonstrated by the large area of wetlands involved in the permitting process.

The recommended mitigation of 7,139 acres could compensate for the habitat losses accepted by NMFS and some of those authorized by the COE during 1987. This, however, assumes that the required mitigation efforts were completed and were successful. It is very important to note that habitat restoration and creation efforts are still experimental. Long-term studies have not been conducted to determine their effectiveness. Efforts are underway at the NMFS Southeast Fisheries Center's Beaufort and Galveston Laboratories to study the efficiency of proposed mitigation projects. However, these efforts must be continued and expanded to obtain information needed to monitor the effectiveness of past mitigation efforts and to develop and improve techniques that NMFS biologists can use to ensure that the impacts of future projects with unavoidable losses of habitat are adequately mitigated.

Research also is necessary to assess the impacts of levees and water control structures used for marsh management, especially in Louisiana. In the last 7 years, the NMFS has been involved in the review of nearly 70 marsh management proposals potentially affecting more than 600 square miles of coastal wetlands. It has been estimated that 25 percent, or about 1 million acres, of coastal Louisiana could be impounded by the year 2000 (Turner et al., 1988). Decisions to allow construction of new coastal impoundments for marsh management represent major Federal actions being taken without an adequate data base on which to make those decisions. Urgently needed are scientific studies to document marsh management impacts on fish and crustacean movements and habitat accessibility, and the effects of management activities on wetland health and longevity. Until such information becomes available, it is likely that developing and approving marsh management plans, which significantly affect estuarine maintenance functions, fishery productivity, and marsh loss, will continue.

Acknowledgments

We are grateful for the assistance of the following NMFS staff in providing the basic data for this paper: Randall Cheek, Larry Hardy, and Ron Sechler in Beaufort, NC: Edwin Keppner, Mark Thompson, and David Nixon in Panama City, Fla.; Donald Moore and Jim Lyon in Galveston, Tex.; and Peggy Keney in Baton Rouge, La. Robert LaFollette and Cheryl Franzen provided the computer support. The following provided critical review and constructive comments: Edwin Keppner, Gordon Thayer, Eugene Turner, Gary Peterson, and William Turner.

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U.S. Catches, Eats Record Amounts of Fish and Shellfish

Americans ate a record amount of seafood for the fourth consecutive year in 1987, consuming 15.4 pounds per person and breaking the 1986 record of 14.7 pounds, according to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. Some 3.7 billion pounds of edible fish and shellfish were consumed by the civilian population. A record consumption of fresh and frozen fish, primarily shrimp, along with a near-record consumption of canned fish, mostly tuna, helped boost the per capita figure, the Commerce Department agency said.

According to NMFS marketing experts, a trend of steadily increasing fish and shellfish consumption since the 1970's, and news that eating fish may help prevent heart disease and other ailments has helped seafood consumption. Improved marketing of quality fresh and frozen fish by air to Midwestern cities was another factor in the increase. The NMFS said Americans are also taking advantage of increased availability of seafood at restaurants and supermarkets, and the appearance of nontraditional species, such as farm-raised catfish and walleye (Alaska) pollock, along with tuna and surimi-based products. The domestic figures reflect the consumption of edible meat, rather than the weight of the whole fish, NOAA said.

Record Landings

Meanwhile, U.S. fishermen landed a record 6.9 billion pounds of fish and shellfish in 1987, valued at $3.1 billion. The new figure breaks the 1980 record of 6.5 billion pounds. Last year's landings rose just over 865 million pounds from the 1986 total of 6 billion pounds, worth $2.8 billion. Fishermen received an average of 45 cents a pound for their fish last year.

Harvests by American fishermen, who landed their catches at ports outside the 50 states or sold their fish at sea in joint venture operations, were an additional 4.1 billion pounds, worth $454 million—an increase in both volume and value from 1986. The NMFS said that increased catches of menhaden at 2.7 billion pounds, followed by Alaska or walleye pollock, at 552 million pounds, were primarily responsible for the new record. Pollock rose 323 percent from 1986, more than ten times higher than the 5-year average of 50.7 million pounds. Landings of tuna, Pacific cod, crabs, and scallops also helped boost the figure. Shrimp landings fell to 363.1 million pounds valued at $578.1 million dollars last year from 400.2 million pounds worth $662.7 million in 1986—a decrease of 37 million pounds and $84.7 million dollars.

Top States

Louisiana led all states in volume with landings of 1.8 billion pounds, followed by Alaska, 1.7 billion pounds; Virginia, 709.6 million pounds; California, 451.7 million pounds; and Mississippi, 436.7

million pounds. Alaska led all states in fish value with $941.7 million, followed by Louisiana, $315.9 million; Massachusetts, $278.9 million; Texas, $199.7 million and California, $173.2 million. World commercial fishery landings were a record at 203.3 billion pounds with Japan continuing to be the leading nation with 13 percent of the total world catch. The Soviet Union was second with 12 percent, followed by China at nine percent, Peru and Chile each with 6 percent and the United States with 5 percent. World commercial fishery landings are based on 1986 data from by the United Nation's Food and Agriculture Organization.

Record Exports

Meanwhile, U.S. fishery exports have been setting a record pace, according to NMFS statistics. Last year (1987), the value of edible fish imports was at its highest ever—$57 billion, while exports also set a record, with U.S. businesses selling $1.6 billion worth of seafood to overseas markets. That represented an increase of almost 48 million pounds in volume and more than $290 million in value over the 1986 figures.

Trade figures for the first 4 months of 1988 indicate sales of about $478 million, a remarkable jump of 48 percent over the same period in 1987. By contrast, fishery imports grew only 4 percent in value in the first 4 months of 1988 compared to the same period in 1987, suggesting that the trade imbalance in fishery products, while still large, is narrowing.

Leading U.S. Ports

New Bedford, Mass., led all other U.S. cities with a record value of fish landings in 1987 and Cameron, La., topped all others in the volume of its catch, according to NMFS data. New Bedford led with more than $143 million worth of fish and shellfish landed, up substantially from $106 million in 1986. Scallops accounted for nearly half of the total dollar value, even though they made up only 21 percent of the total fish landed. Cameron, as in the past 10 years, led in volume, with 672 million pounds of fish landed. Most were low-value but industrially important menhaden.

Other shifts include a rise in fish value and quantity for Dutch Harbor-Unalaska and Kodiak, Alaska, from increased landings of walleye pollock, Pacific cod, plaice, and sole, mostly used in Alaskan processing plants to produce fillets and surimi. Hampton Roads, Va., made substantial gains from higher prices and landings for fluke and increased volume in scallops. The 10 leading U.S. ports in volume of fish and shellfish landed in 1987 (in millions of pounds), with 1986 figures for comparison:

Port	1987	1986
Cameron, La.	672.4	616.8
Pascagoula-Moss Point, Miss.	391.6	365.5
Empire-Venice, La.	357.4	317.6
Dulac-Chauvin, La.	331.7	294.6
International City, La.	314.3	298.9
Kodiak, Alaska	204.1	141.2
Los Angeles, Calif.	203.1	187.4
Dutch Harbor-Unalaska, Alaska	128.2	88.3
Gloucester, Mass.	93.0	110.0
Beaufort-Morehead City, N.C.	85.7	98.9

The ten leading U.S. ports in value of fish and shellfish landed in 1987 (in million of dollars), with 1986 figures for comparison:

Port	1987	1986
New Bedford, Mass.	143.7	106.0
Kodiak, Alaska	132.1	89.8
Dulac-Chauvin, La.	65.6	71.0
Dutch Harbor-Unalaska, Alaska	62.7	37.2
Empire-Venice, La.	60.1	47.1
Los Angeles, Calif.	55.6	29.5
Brownsville-Port Isabel, Texas	54.2	69.3
Hampton Roads Areas, Va.	46.2	23.6
Cordova, Alaska	41,9	N/A
Petersburg, Alaska	36.9	38.1

New England Fish Harvest Value Is Up, Weight Down

Preliminary figures for commercial landings of New England fish and shellfish during 1987 were 543.7 million pounds, valued at 512.6 million dollars. These 1987 figures are down 12.0 million pounds and up 63.7 million dollars from the 1986 figures, according to Allen E. Peterson, Jr., Science and Research Director of the National Marine Fisheries Service's Northeast Region.

Table 1.—Preliminary weights[1] and values of fish and shellfish landings in New England on a state-by-state basis for 1986 and 1987.

State	1986 Million pounds	1986 Million dollars	1987 Million pounds	1987 Million dollars
Massachusetts	271.3	243.6	256.8	278.9
Maine	168.2	108.4	169.0	132.4
Rhode Island	101.6	75.1	100.0	77.5
New Hampshire	7.9	6.2	9.3	7.8
Connecticut	6.7	15.6	8.6	16.0
Totals	555.7	448.9	543.7	512.6

[1]Landings of fish, lobster, and crab in live weight; landings of other shellfish in meat weight.

Table 2.—Preliminary weights[1] and values of fish and shellfish landings in New England on a port-by-port basis for 1986 and 1987.

Port	1986 Million pounds	1986 Million dollars	1987 Million pounds	1987 Million dollars
Gloucester, MA	109.6	37.8	92.6	34.0
New Bedford, MA	90.6	103.2	78.5	143.7
Pt. Judith, RI	56.8	28.0	46.5	29.6
Portland, ME	34.3	22.4	43.4	35.6
Rockland, ME	42.7	9.1	38.6	8.1
Boaston, MA	30.7	19.0	22.5	17.0
Newport, RI	16.8	13.3	11.8	12.6

[1]Landings of fish, lobster, and crab in live weight; landings of other shellfish in meat weight.

Table 3.—Preliminary weights[1] and values of fish and shellfish landings in New England on a species-by-species basis for 1986 and 1987.

Species	1986 Million pounds	1986 Million dollars	1987 Million pounds	1987 Million dollars
Atlantic herring	70.4	3.8	84.5	4.4
Atlantic cod	60.8	35.6	58.4	43.7
Pollock	54.4	14.0	44.6	17.8
American lobster	43.3	112.2	42.8	124.7
Silver hake	34.4	5.9	25.9	7.3
Winter flounder	16.3	16.8	18.4	22.7
Sea scallop	11.4	60.1	18.2	80.6
Yellowtail flounder	22.2	20.5	16.4	18.7
White hake	14.6	4.9	11.7	5.2
Northern shrimp	10.3	6.5	11.1	12.2
Summer fl. (fluke)	10.0	13.1	8.7	14.3
Scup	8.0	4.3	7.8	5.1
Swordfish	2.2	7.0	7.7	8.6
Haddock	10.9	10.9	6.6	8.5

[1]Landings of fish, lobster, and crab in live weight; landings of other shellfish in meat weight.

Table 4.—Preliminary weights (live) and values of American lobster landings in New England on a state-by-state basis for 1986 and 1987.

State	1986 Million pounds	1986 Million dollars	1987 Million pounds	1987 Million dollars
Maine	19.7	46.2	19.8	54.6
Massachusetts	15.0	41.0	15.0	43.8
Rhode Island	5.1	16.7	5.3	17.8
Connecticut	1.8	5.4	1.6	5.3
New Hampshire	1.1	2.8	1.1	3.2
Totals	42.7	112.1	42.8	124.7

Landings of such traditionally important groundfishes as cod, haddock, and yellowtail flounder decreased by 12.0 million pounds in 1987 compared with 1986, continuing a multiyear decline in the landings of those species. Peterson sees "no change in this trend" for 1988. Landings of sea scallops increased by 6.8 million pounds and 20.5 million dollars in 1987 compared to 1986, to reach an all-time high of 18.2 million pounds and 80.6 million dollars.

Tables 1-3 compare the weights and values of New England landings in 1986 and 1987 on a state, port, and species basis. Table 4 has also been included on landings of American lobsters in each of the New England states.

Continued Expansion Seen for N.E. Marine Angling

Northeastern U.S. marine anglers will increase in numbers by at least 34 percent by the year 2025, bringing the total to nearly 5 million anglers. That's the prediction of NMFS Northeast Fisheries Center scientists as presented in a talk at the Symposium on Demand and Supply of Sport Fishing, held in Charleston, S.C., earlier this year. The predicted increase comes on the heels of a 200 percent increase in the last 30 years.

The model used by Northeast Fisheries Center scientists to make these predictions relies on projections of population size and the closeness of the population to the shoreline. Future NEFC research will extend the predictions to include specific fisheries (e.g., bluefish, summer flounder) and fishing modes (e.g., charter boat fishing, shore fishing).

Evans Confirmed As NOAA Administrator, IWC Commissioner

Williams E. Evans was sworn into office on Friday, 1 April 1988, as Under Secretary of Commerce for Oceans and Atmosphere, and Administrator of the Commerce Department's National Oceanic and Atmospheric Administration (NOAA). Evans was nominated to his position by President Ronald W. Reagan after a year and a half as NOAA's Assistant Administrator for Fisheries. His nomination was confirmed by the Senate on Thursday, 31 March.

As head of the National Marine Fisheries Service, he was responsible for management and enforcement of fishery resources, and conservation and protection of threatened and endangered marine mammals. He is President Emeritus of the Hubbs Marine Research Institute in San Diego, Calif., and Chairman Emeritus of the U.S. Marine Mammal Commission. He is widely recognized for research on the effects of acoustics on the behavior of marine mammals.

Evans has conducted aerial surveys to collect and evaluate data for stock estimates of dolphins and has done extensive research for the Navy on the dolphin's ability to navigate and adapt to the ocean environment. He has pioneered in use of remote sensing data from satellites for biological oceanography. He has published over 100 scientific articles and chapters in textbooks, is affiliated with numerous professional organizations, and has taught at several major universities. He has received many awards for science and public service. Evans received a Ph.D. in physiology, ecology, biology, and animal behavior from the University of California at Los Angeles, a master's degree from Ohio State University, and a bachelor's degree in education from Bowling Green State University. He is married and the father of two sons.

More recently, Evans has been appointed United States Commissioner on the International Whaling Commission. Evans' appointment to the 41-nation organization that regulates commercial whaling internationally, was announced by the White House on 25 May.

As administrator of NOAA, Evans establishes Federal policies and directs programs to improve the understanding, management, conservation, and development of the nation's marine and atmospheric resources for economic and social benefit.

Brennan Heads National Marine Fisheries Service

James W. Brennan, deputy general counsel for the National Oceanic and Atmospheric Administration (NOAA), was named to head the agency's National Marine Fisheries Service in early June. As assistant administrator for fisheries in the Commerce Department agency, Brennan will be responsible for management of fishery resources in the Nation's 200-mile Exclusive Economic Zone, and protection of threatened and endangered marine animals.

Brennan has been with NOAA's Office of General Counsel since 1971. Before that he worked at the Commerce Department's Patent Office and the Office of Naval Research. He holds a B.S. in chemical engineering from the University of Rochester and a law degree from Georgetown Law Center. He has done post-graduate legal studies at the University of Frankfurt in West Germany. He is married with six children and lives in Vienna, Virginia.

Boehlert Named to Head NMFS Honolulu Laboratory

George W. Boehlert, 38, has been selected as the new director of the National Marine Fisheries Service laboratory in Honolulu, Hawaii, reports Izadore Barrett, Science and Research Director of the NMFS Southwest Region. Boehlert has led the fisheries laboratory's research program on the physical and biological interactions in seamount and island ecosystems since 1983. He is the author of many scientific papers on these subjects as well as on the reproduction, ageing, and growth

of fishes, and the physiological responses of fishes to environmental changes.

Before joining the Laboratory staff, Boehlert was an Associate Professor of Oceanography at Oregon State University. He graduated from the University of California, Santa Barbara in 1972 with a Phi Beta Kappa key. He received his Ph.D. in marine biology from the University of California's world-famous Scripps Institution of Oceanography in 1977. He is married to the former Susan Shimp, and they have two sons, Brent and Brooks.

As Director of the Honolulu Laboratory, which started as the Pacific Oceanic Fishery Investigations in 1949, Boehlert leads a group of 80-90 fishery scientists and support staff in conducting research programs throughout the central and western Pacific which range from studies of the biology and habitat of tuna, billfish, bottomfish, lobster and deep-sea shrimp to studies of the endangered Hawaiian monk seal and threatened green sea turtle. Boehlert replaces Richard S. Shomura who stepped down after 15 years as the Director of the Honolulu Laboratory to pursue several fishery-related projects before his planned retirement from federal service in August, 1988.

Peterson Selected As NOAA Chief Scientist

"NOAA is a science organization," stated William E. Evans, Under Secretary of Commerce for Oceans and Atmosphere, as he announced the selection of Melvin N. A. Peterson to fill the new position of NOAA Chief Scientist in April. NOAA, said Evans, has one of the finest groups of scientists in the world, and its mission, he pointed out, is unique in environmental observation, prediction, and supporting research and information management.

The new Chief Scientist can contribute to NOAA's pursuit of its mission in several ways, Evans noted. Internally, he can act to preserve and enhance the excellence of NOAA's science staff and the facilities and resources available to NOAA scientists. Externally, the Chief Scientist can help coordinate and promote NOAA's programs within the larger research community, Evans said, adding that the Chief Scientist can also be instrumental in identifying and fostering new ways for Federal agencies and other institutions to work together in service to the American people. Prior to coming to NOAA, Peterson served as Director of the Deep Sea Drilling Program at Scripps Institution of Oceanography, and he draws upon a broad range of research and operational experience, as well as extensive national and international contacts.

Shark Tagging Provides Needed Biological Data

In 1987 a total of 5,760 sharks and teleosts (bony fishes) representing 41 species were tagged under the Cooperative Shark Tagging Program (Table 1). The releases were made by volunteer anglers (54 percent), U.S. Foreign Fisheries Observers (30 percent), commercial fishermen (10 percent) and other biologists (6 percent). NMFS biologists did not tag for the first time in 25 years. Even so, the number of releases last year increased to 750 more than in 1986 with the capture gear about equally divided between longline and rod-and-reel.

The annual variations in the number of fish tagged (e.g., 3,700+ in 1984 and 7,000+ in 1985) depends on several factors. We expect there are natural cycles of increased and decreased abundance, but almost nothing is known about these cycles with respect to sharks. Actually,

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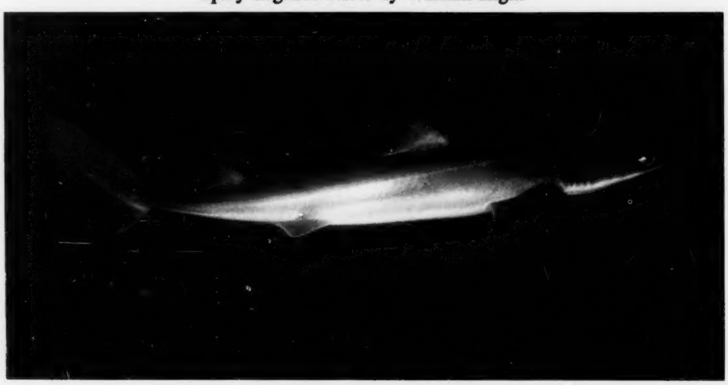
Table 1.—Summary of sharks and teleosts tagged by cooperative taggers, Jan.-Dec. 1987.

Species	No. tagged	Species	No. tagged
Sharks		Sharks cont.	
Blue shark	2,638	Bignose shark	2
Sandbar shark	632	Smooth spiny dogfish	2
Dusky shark	343	Spiny dogfish	2
Tiger shark	293	White shark	1
Shortfin mako	259	Carib. sharpnose shark	1
Lemon shark	252	Leopard shark	1
Atl. sharpnose shark	206	Whale shark	1
Blacktip shark	189	Hammerhead unspec.	48
Porbeagle	91	Thresher unspec.	26
Nurse shark	91	Brown/Dusky unspec.	14
Bigeye thresher	56	Blacktip unspec.	8
Scalloped hammerhead	51	Sand unspec.	8
Sand tiger	51	Dogfish unspec.	4
Blacknose shark	46	*Carcharhinus* unspec.	4
Basking shark	33	Miscellaneous[1]	34
Spinner shark	26	Subtotal	5,559
Bull shark	24		
Reef shark	23	Teleosts	
Silky shark	19	Swordfish	122
Bonnethead	16	White marlin	15
Smooth hammerhead	15	Blue marlin	15
Longfin mako	13	Sailfish	3
Oceanic whitetip shark	12	Billfishes	3
Great hammerhead	7	Bluefin tuna	2
Greenland shark	6	Longbill spearfish	1
Night shark	4	Tuna unspec.	1
Finetooth shark	4	Miscellaneous	39
Thresher shark	3	Subtotal	201
		Grand total	5,760

Spiny dogfish. Photo by William High.



the total number of sharks tagged in a particular year is related more to fishing activities than to changes in abundance. For example, NMFS biologists may have one or two research cruises in some years and none in others. The number of fish tagged by U.S. Fisheries Observers aboard foreign vessels depends largely on the number of foreign vessels permitted in that fishery. Last year more sharks were tagged by southern commercial shark fishermen in that expanding fishery. Considering only the number of sharks tagged by anglers in the past 10 years, the number of releases has declined slightly despite an increase in the number of participants. But even in that category annual trends must be interpreted with caution.

The number of sharks tagged by anglers is influenced by a variety of factors from weekend weather conditions, changes in the distribution of common sharks in some years, increased utilization of sharks for food, an increase in shark fishing tournaments, and a shift in fishing effort by some of our most expert taggers to other species such as tunas. As a consequence of these and other variables, the total number of sharks tagged has limitations as a measure of population abundance. On the other hand, tagging data is vital to the understanding of shark migrations, age, and growth; distribution, seasonal occurrence, and other aspects of their biology.

A total of 210 tags from 19 species were returned in 1987. Recaptures came from anglers (40 percent), U.S. commercial fishermen (33 percent), foreign fishermen (21 percent), U.S. Foreign Fisheries Observers on foreign vessels (3 percent), and other biologists (3 percent). Tags were returned from the following 14 countries and island territories: United States, 149; Japan, 14; Mexico, 12; Spain, 10; Canada, 7; Cuba, 5; Columbia, 3; Taiwan, 2; Portugal, 2; Bermuda, 2; Bahamas, 1; St. Martin, 1; Barbados, 1; and Canary Islands, 1. Sharks recaptured in 1987 had originally been tagged by anglers (60 percent), U.S. Foreign Fisheries Observers (17 percent), NMFS and other biologists (16 percent), and U.S. commercial fishermen (7 percent).

Blue sharks provided 69 returns. The maximum time at liberty for a blue shark was 6.0 years and the maximum distance travelled was 3,251 miles. While some blues were recaptured near the release site after 4 years at liberty, others travelled considerable distances in a relatively short time (e.g., 546 miles in 39 days or 14 miles per day). Long-distance movements by blues tagged off the U.S. coast included 6 recaptures from Canada, 3 from Azores, 3 from Colombia, 2 from Portugal, 2 from Cuba, and 1 from the West Indies. Some returns from Spanish longliners came from areas between the Azores and the Grand Banks that are fished by American, Canadian, and Japanese vessels. In recent years, the eastward expansion of the U.S. and the westward expansion of the Spanish longline fishery is evidence that several nations have the capability to target highly pelagic species anywhere in the Atlantic. One would expect that sharks will be increasingly important to these fisheries, perhaps in the not too distant future.

Sandbar sharks provided 44 returns. The maximum time at liberty for a sandbar shark was 21.8 years and the maximum distance travelled was 1,945 miles. This is the longest time at liberty for any shark tagged under the program. Eight of the recaptures had been tagged by NMFS biologists aboard the Polish research vessel *Wieczno* during the 1986 longline survey conducted between New England and southern Florida. A total of 264 sandbar sharks were tagged on that cruise and the eight recaptures ranged in distance from 4 to 1,100 miles over a 9.7-month period. Other sandbar recaptures demonstrated movements from the northeastern United States into the Gulf of Mexico. The predominantly north to south pattern shown by tagged sandbar sharks is in part explained by the larger number tagged off the northeast coast. Additional tagging off Florida and in the Gulf of Mexico, including the coast of Mexico, is needed to determine if sandbar sharks commonly return north from these areas.

In recent years, commercial shark fishing off Florida has been expanding. Thirty-one (70 percent) of the 1987 returns from sandbar sharks came from longline vessels fishing off Florida or Mexico. Fortunately, some U.S. commercial shark fishermen are also avid taggers, and have provided data and vertebrae from tagged sharks for age studies. Fishermen who know about sharks also know that the stocks are highly susceptible to intensive fishing. Both recreational and commercial interests are concerned that populations of some sharks will be seriously impacted by increased fishing. This concern is justified based on the past history of shark fisheries throughout the world. The sandbar shark was the most abundant species in the U.S. commercial shark fishery along the Atlantic Coast during the 1940's.

Mako sharks provided 19 returns. The maximum time at liberty for a mako was 4.0 years and the maximum distance travelled was 1,412 miles. The distance between tag and recapture exceeded 1,200 miles for six (32 percent) of the returns. Three makos tagged in the Mid-Atlantic Bight (i.e., between Cape Hatteras and Cape Cod) were recaptured about 600 miles east of the Grand Banks by Spanish longliners. Two additional makos tagged in the Mid-Atlantic Bight were recaptured near Cuba. Last year we also had the first recapture of a mako shark showing movement into the Gulf of Maine. The expanding recreational shark fishery in the Gulf of Maine may reveal a higher abundance of sharks than indicated by the low numbers of tag returns from that area.

Tiger sharks provided 12 returns. The maximum time at liberty for a tiger shark was 5.5 years and the maximum distance travelled was 1,126 miles. A tiger shark released off Montauk, N.Y., and recaptured off Cuba is the third to show movements of this species between the United States and Cuba. Of the long-distance returns (i.e., over 700 miles), three tiger sharks showed southward movements from New York and New Jersey to Florida and Cuba, and one travelled northward from Florida to New York. The fastest rate of travel was 15.1 miles per day for an individual tagged off New York in late July and recaptured off Florida in September. These long-distance north-south move-

ments of tiger sharks are interesting in that it was not too long ago that tiger sharks taken north of Cape Hatteras were thought to be tropical strays. Four of the recaptures were at liberty for over 3 years and their vertebrae would have been valuable for age studies. Fishermen are urged to make every attempt to collect vertebrae from any tagged shark recaptured.

Tag returns from other species included: Scalloped hammerheads that were at liberty for up to 9.6 years, and a maximum distance of 765 miles (both records for this species); blacktip sharks that were at liberty for up to 7 years, and a maximum distance travelled of 1,159 miles between North Carolina and the Gulf of Mexico (both records for this species); dusky sharks that were at liberty for up to 11.8 years (a new record for this species) and a maximum distance travelled of 1,385 miles (three dusky recaptures showed movements from the U.S. east coast to Mexico); nightsharks that were at liberty for up to 8.8 years and a maximum distance travelled of 1,441 miles between Maryland and Mexico (a new distance record and second evidence of movement of this species between the two countries); and reef sharks recaptured at the same location off Bermuda after 1.2 and 2.2 years that were retagged and are still at liberty. Returns from lemon, nurse, and other sharks were primarily local recaptures that provided early life history information on young sharks that were still on inshore nursery grounds.

Tags were also returned from five swordfish, including one at liberty for 7.6 years. One swordfish recaptured in 1987 is the first to demonstrate movements of swordfish from the offings of the Grand Banks to the Virgin Islands. (In March 1988 we received another swordfish return showing movement from Georges Bank to Haiti.) Recaptures from two additional swordfish tagged off Georges Bank included one from the Grand Banks and one from the Straits of Florida.

Tag and Recapture Update

In the first five months of 1988, a total of 1,000 sharks representing 27 species were tagged under the Cooperative Shark Tagging Program. The major species tagged were: Blue sharks released by U.S. Foreign Fisheries Observers aboard Japanese tuna longliners fishing off Georges Bank and the Middle Atlantic Bight; sandbar sharks and tiger sharks released by U.S. commercial shark longliners off eastern Florida and in the Gulf of Mexico.

An important aspect of this spring's tagging was that one commercial longliner tagged over 250 nearly full term sandbar shark embryos. The survival rate of embryos taken from pregnant sharks and returned to the sea is not known and is a difficult problem to study. The efforts of fishermen in tagging embryos can provide vital information. In the past 23 years, we have only had about 30 embryos tagged. The opportunities to do so are very limited. The only first hand information we can offer on this subject is that several years ago, one of our commercial longliners tagged several dusky shark embryos taken from a pregnant female in the Gulf of Mexico and one was recaptured after 25 days. Our advice regarding tagging has always been that sharks of all sizes are susceptible to internal injuries during capture and should be treated gently to insure maximum survival. However, when in doubt, release them and give them a chance. We have had recaptures from sharks that were considered in poor condition when they were released.

From January through May, a total of 51 tags were returned from 12 shark species including blue (17), sandbar (13), tiger (5), dusky (3), mako (2), and others (11). Blue sharks were at liberty for up to 3 years with eight returns showing long-distance movements of 1,200-2,500 miles. Recaptures from blue sharks tagged off the northeastern U.S. included one return from off Madeira Island in the eastern Atlantic and several returns from off the West Indies and South America. Nearly all of the tagged sandbar sharks were free for over 1 year and included recaptures after 7, 10, and 23 years (the maximum time at liberty to date). Seven of the thirteen sandbar sharks travelled over 1,200 miles, mainly from New York and New Jersey, into the Gulf of Mexico. Most of the tiger shark returns were short term recaptures although one was recaptured after 2.5 years and showed and 800-mile movement from New England to Florida. Three tagged tiger sharks were caught and released with the tags still in place.

Other interesting returns included a tagged dusky shark that travelled from off Alabama to Mexico in 7 months; a bignose shark tagged off Maryland and recaptured off Alabama after 3 years (evidence that this species moves between the Atlantic and Gulf of Mexico); and a porbeagle shark tagged off the Flemish Cap and recaptured 300 miles west of the tagging site after 4 years. We also had two tag returns from swordfish—both were released off New England. One was recaptured off Florida after 2.5 years; the other, taken off Haiti, travelled 1,250 miles in 57 days (22 miles/day). In addition to the above information, we were fortunate to receive vertebrae from several recaptured sharks and some very valuable growth information from sharks that had been measured both at tag and recapture.

Jack Casey

Shark Tagging Studies

Shark tagging programs throughout the world have been directed toward several objectives, including studies of migrations, age and growth, physiology, population dynamics, and swimming behavior in the open sea. Tagging studies on sharks have been conducted by researchers from Australia, Canada, Great Britain, Greenland, Ireland, Norway, South Africa, South America, Japan, and the United States.

Results of these studies include recaptures from tagged Australian school sharks over a 30-year-period, recaptures from sandbar sharks and spiny dogfish after 20 years, and recapture of a Greenland shark after 16 years. Acoustic telemetry has been used to measure average swimming speeds, diurnal movements, depth ranges and other aspects of the behavior of several species including lemon, reef, blacktip, hammerhead, and blue sharks.

The most extensive shark tagging program in the world has been conducted by the National Marine Fisheries Service in the North Atlantic Ocean. This continuing study, covering 25 years, currently involves over 3,000 volunteer fishermen and scientists along the North American and European coasts. Under this program 67,607 sharks representing 43 species were tagged between 1962 and 1986. In the same period 2,337 sharks of 30 species were recaptured by fishermen representing 24 countries. Results of the U.S. program include: Transatlantic movements of the blue sharks between North America, Europe, Africa, and South America (maximum distance = 3,740 miles), recaptures from sandbar sharks showing movements between the United States, Cuba, and Mexico; recaptures of 10 shark species demonstrating movements between the Atlantic and the Gulf of Mexico, and recaptures of night, blacktip, tiger, bigeye thresher, sandbar, and dusky sharks between North America and the West Indies.

J. G. Casey and N. E. Kohler

Monk Seal Pups Get Honolulu Head Start

Two Hawaiian monk seal pups from French Frigate Shoals are getting a new lease on life as part of a head start program aimed at enhancing the survival rate of this endangered species. The pups, both small females, were flown to Honolulu, Hawaii, on 13 May 1988, so that they could "fatten up" overwinter while learning the basic principles of eating, according to William G. Gilmartin, program manager of the Marine Mammals and Endangered Species Program of the Honolulu Laboratory of the NMFS Southwest Fisheries Center.

For now, the pups, which are being held at the NMFS tank at Kewalo Basin, must be force fed dead fish so that they eat enough to survive. Next March, they will be flown to Kure Atoll, Northwestern Hawaiian Islands, where the number of monk seals is very low. Once at Kure, the seals will spend 2-4 weeks, learning to forage within the protective confines of a large wire mesh enclosure that spans equal areas of ocean and sand. Only after they are catching live fish and invertebrates and feeding on their own will they be released.

"All the pups brought to Honolulu as part of the head start program have been very small and probably wouldn't have survived if left in the wild," said Gilmartin. Some pups have problems more serious than simply being small, problems such as congenital diseases or deformities that are life threatening. Before the seals are reintroduced to the wild, they are carefully screened for disease and genetic problems.

A congenital problem may be why a third pup that arrived in Honolulu on Friday died that same night. Gilmartin and NMFS biologist Doris J. Alcorn performed a necropsy on the animal, but the results will not be available for a few weeks, so cause of death is unknown. "If there is not a congenital problem, the chance of survival for the rehabilitated pups increases from less than 40 percent to nearly 100 percent. There's no reason to gamble by leaving undersized pups to overwinter at French Frigate Shoals," said Gilmartin, adding that "Of the nine pups successfully treated and released since 1985, all are still alive." Friday's airlife was made possible by the Captain Bob Justman, who volunteered his time to fly to French Frigate Shoals to pick up the pups and deliver them to Honolulu.

Introducing just a few females each year is a significant addition to the Kure population: The introduced female pups outnumber the females born at Kure in the past few years. Monk seal births at Kure declined from 30 per year in the mid-1960's to one in 1986. So far in 1988, the number of Kure births is at seven, the highest number since 10 were born in 1981.

The three undersized pups probably were weaned half way through the normal nursing period of 40 days. In the wild, weaned pups must live off their fat reserves for the next 2-4 months while learning to catch fish on their own. Catching fish is a survival technique their mothers do not teach them. Unfortunately, small pups have less fat and therefore less time to learn. Naturally curious, pups play in the water with fish, invertebrates and whatever else catches their fancy. Eventually, by accident or instinctively, they learn to forage on their own.

A contributing factor for the pups' reduced nursing times is that good pupping habitat is limited at French Frigate Shoals. That problem is compounded by the fact that French Frigate Shoals supports just over half the monk seal population of the Northwestern Hawaiian Islands and that, of the approximately 200 monk seal births in 1987, about half occurred at French Frigate Shoals. Reduced nursing time is also due to monk seals' not being as good as other seal species at recognizing their own pups. As a result, pups may wander away or be displaced by larger pups without the mothers ever noticing.

Another part of the NMFS head start program at Kure Atoll involves weaned Kure females that are placed in the ocean-beach enclosure for protection from sharks and other seals, particularly males. Pups learn to forage on fish and invertebrates that are placed by dip net into the ocean portion of the enclosure while the pups are asleep on the beach. At the end of the field season, usually in September, the pups are released to the wild. As of 1987, 26 of the 27 introduced or Kure-born seals from the head start program are still alive. Some of the older seals from the program are now giving birth, so head start is in its second generation of seals. The U.S. Fish and Wildlife Service assists in collecting the pups and bringing them to Honolulu; the U.S. Coast Guard transports the pups to Kure via a C-130 plane and provides some assistance in collect-

ing live food for the seals at Kure. Volunteers help with the feeding and care of the pups in Honolulu.

1,100 Endangered Turtles Get Head Started in Gulf

About 1,100 yearling sea turtles were released off Padre Island, Tex., on Tuesday, 17 May, as part of a continuing effort to increase their endangered population, the National Oceanic and Atmospheric Administration has announced. With the release of Kemp's ridley sea turtles into the Gulf of Mexico, scientists with NOAA's National Marine Fisheries Service Galveston Laboratory will be completing part of an annual recurring job that began in 1978. Since that year, researchers from the United States and Mexico have been cooperating in an experiment dubbed Operation Head Start, which has reared, tagged, and released more than 13,500 Kemp's ridleys.

Each spring, turtle eggs are collected from the animals' primary nesting beach at Rancho Nuevo, Mexico. From there they are airlifted to Texas' Padre Island National Seashore, where they are incubated. After hatching, the baby turtles are allowed to crawl to the surf as part of the process called imprinting. The turtles are then scooped up in nets, put in boxes and sent to the Fisheries Service laboratory in Galveston, Tex., to be reared for 9-10 months before release. Scientists say the imprinting stage is crucial because they believe it allows the turtles to recognize instinctively where they have nested so that after they have matured they might return and create a new nesting ground at Padre Island.

Protecting the young turtles from predators during their critical first year gives them a much better chance of surviving to maturity, according to Edward F. Klima, director of the Galveston Laboratory. Even though the rearing, tagging, and releasing have been successful, Klima said, it remains to be seen if the turtles will return to nest in the future. He said it can take 10 years or more before the turtles mature.

Over the last nine years, more than 500 head-started turtles have been recovered. "We find that the turtles are able to grow and survive in the wild," said Klima. In addition to the Fisheries Service, other organizations involved in the project include the Instituto Nacional de la Pesca in Mexico and the Interior Department and the U.S. Coast Guard. The University of Texas provides the research vessel used in the release. The Texas Parks and Wildlife Department and the Florida Department of Natural Resources have also contributed to the program.

NMFS Outstanding Publications Cited

Winners of the National Marine Fisheries Service's Outstanding Publications Award for papers published in the *Marine Fisheries Review* (vol. 47) and the *Fishery Bulletin* (vol. 84) have been announced by NMFS Publications Advisory Committee Chairman Ben Drucker.

"Starvation-Induced Mortality of Young Sea-Caught Jack Mackerel, *Trachurus symmetricus*, Determined with Histological and Morphological Methods" by Gail Theilacker, was selected as the top paper in the *Fishery Bulletin*, 84:1-17. Theilacker is with the NMFS Southwest Fisheries Center, La Jolla, Calif.

Honored for the best paper published in the *Marine Fisheries Review* was Susumu Kato for "Biology of the Red Sea Urchin, *Stronglyocentrotus franciscanus*, and Its Fishery in California," 47(3):1-20. Kato is with the NMFS Southwest Fisheries Center's Tiburon Laboratory, Tiburon, Calif.

Developed in 1975, the annual outstanding publication awards program recognizes NMFS employees who have made exceptional contributions to the knowledge and understanding of the resources, processes, and organisms studied as a part of the NMFS mission. Authors must have been employed by the NMFS at the time the paper was published. *Marine Fisheries Review* papers must be effective and interpretative contributions to the understanding and knowledge of NMFS mission-related studies, while *Fishery Bulletin* papers must document outstanding scientific work. The Awards Committee is chaired by the editor of the *Fishery Bulletin*, currently Andrew Dizon of the NMFS Southwest Fisheries Center. Other Committee members include the editor of the *Marine Fisheries Review*, W. L. Hobart, and former *Fishery Bulletin* editors Bruce B. Collette, Jay Quast, William J. Richards, and Carl Sindermann.

Maurice Stansby Receives Distinguished Federal Civilian Service Award

Secretary of Commerce C. William Verity presented Maurice E. Stansby of Seattle, Wash., the President's Award for Distinguished Federal Civilian Service at special ceremonies held on 7 March at the Department of Commerce building in Washington, D.C. Stansby was chosen for the award because of his research on the health benefits of fish oil in the human diet. He is the first Department of Commerce employee to receive this award.

Before the benefits of fish oil in the human diet were recognized, Stansby pioneered a fish oil research program in the 1950's while director of the U.S. Fish and Wildlife Service's Technological Laboratory in Seattle. As part of this program, he initiated agreements with the Food Science Department of the University of California, the Hormel Institute, and the University of Minnesota. The results of these research agreements definitely established that fish oil contains certain fatty acids which can reduce cholesterol and triglyceride levels in blood. Stansby has edited several books and published 170 research papers, more than one-third of which deal with fish oils.

Stansby began his Federal fisheries career in 1931 as a chemist with the U.S. Fish and Wildlife Service, Gloucester, Mass. Although he officially retired from government service in 1976, he has continued his work at the NMFS Northwest and Alaska Fisheries Center on a volunteer basis. He has attended meetings, often at his own expense, diligently updated scientific information, and encouraged local conferences and forums

to promote the scientific community's understanding of the benefits of fish oil to human health. One of his more recent contributions is an article on the history of fish oil research to the special historical 50th Anniversary Issue of the *Marine Fisheries Review* (in press).

Peterson Elected NASCO President

Allen E. Peterson, Jr., of Sandwich, Mass., has been named president of the North Atlantic Salmon Conservation Organization (NASCO). Peterson was elected at the June annual meeting of the international organization, which was held in Reykjavik, Iceland. NASCO operates under a 1983 treaty signed by nine parties agreeing to promote conservation, restoration, enhancement, and good management of Atlantic salmon stocks.

Peterson is also science and research director of the National Marine Fisheries Service's Northeast Fisheries Center in Woods Hole, Massachusetts. He will replace Gudmunder Eiriksson of Iceland, who retired at the end of the meeting. Norway's Svein Aage Mehli will serve as NASCO vice president.

Peterson is one of three U.S. commissioners to NASCO. Commissioners Frank E. Carlton of Savannah, Ga., and Richard A. Buck of Dublin, N.H., also attended, along with other government advisors and scientists. Similar delegations were present from the other signatory parties: Canada, Denmark, the European Economic Community, Finland, Iceland, Norway, the Soviet Union, and Sweden.

NASCO is organized geographically, with three commissions covering the Atlantic region and a council. The North American and Northeast Atlantic Commissions have long-term fishery management measures in place, and discussed the effectiveness of these measures, the state of the fisheries, and the scientific advice received on the salmon stocks. The West Greenland Commission negotiated an agreement for regulating total catch during 1988-1990. The agreement sets total catch for the three years at 2,520 metric tons, with catch in any one year not to exceed the annual average of 840 metric tons by more than 10 percent.

The NASCO council discussed analyses of catch statistics, compilation of salmon tagging data, and a reward program to encourage tag returns. The council also took under advisement reports on threats to wild salmon posed by salmon aquaculture in the North Atlantic and by nonindigenous trout and salmon that may be introduced, imported, or transferred to North Atlantic areas. The next NASCO annual meeting will be held in Edinburgh, Scotland, in June 1989.

NMFS Honolulu Lab Aids Palau Fishery Surveys

"How much fish is being caught and eaten by the residents of Palau?" That's just one of the many questions that will be answered by a project implemented in May 1988 by the Palau Marine Resources Division (PMRD), with assistance from the National Marine Fisheries Service (NMFS).

To survey the fishing activities of Palauans, the Palau Subsistence Fishery Survey Project uses two questionnaires, one for those who own boats and one for those who do not. The questionnaires and survey techniques were designed by Paul Gates, who is the project's principal investigator and also a fisheries biologist with the Western Pacific Regional Fishery Management Council in Honolulu, and David C. Hamm, a computer systems analyst with the NMFS Honolulu Laboratory of the Southwest Fisheries Center.

The surveys will provide an estimate of the subsistence catch and verify the commercial catch estimates obtained from a system PMRD already has in place. According to Gates and Hamm, this type of information is necessary for determining whether fisheries management is needed in Palau.

"Most of the Pacific island countries have few land-based natural resources, so their economic development is linked to the ocean's resources," said Gates. "So far, most have encountered difficulties in establishing locally based commercial fishing industries." The subsistence catch is typically high in the Pacific islands, particularly in rural areas where electricity and refrigeration are nonexistent and, if jobs exist, wages are very low.

"In Palau, fish are an extremely important natural resource," said Hamm. "Almost every adult male fishes, and the people of Palau especially depend on the inshore fisheries. The per capita consumption of fish is very large. Just how large is something the survey will tell us." Added Gates, "A similar study in Yap found that 90 percent of the fish caught were for subsistence." Besides the subsistence catch, the surveys will also provide information on the number of boats in Palau, the primary species harvested by each fishing method commonly used and how fishermen compare fishing today with 5 years ago.

Quantifying the subsistence catch will be particularly difficult. Palau has no subsistence fishing license or boat registration requirements. Nor does Palau have a catch limit. The surveys will obtain information that is currently unavailable. "In the tropics, it's hard to get a good picture of what's going on. There are so many species of fish. If you went spearfishing in Palau, you might catch 30 or more species of fish," said Gates. "Palau has over 1,000 species of fish."

Conducting the actual surveys will be no easy task: All but 1 of Palau's 16 states are rural areas with villages spread across islands and atolls. "A lot of the villages are approachable only by water and only at high tide," said Hamm. Palau also has a broad spectrum of lifestyles. The largest state, Koror, is fairly metropolitan, whereas other states such as Hatohbei have no electricity, no modern conveniences. The survey design had to account for these differences.

The clan system in Palau will make it easier to determine the number of boat owners, according to Gates. The people network will help identify and locate all the boat owners within a village. The surveys will be conducted by three PMRD employees trained in survey techniques by Gates and Hamm, who also set up a system to computerize the

information gathered during the surveys.

"The PMRD staff is very capable," said Gates. He is optimistic about the future results from the surveys and hopes that someday there will be a standardized procedure for obtaining data on subsistence catches for all Pacific island nations so that the results are comparable.

Palauans favor several fishing methods: Daytime and nighttime spearfishing inside and outside the reefs; hook-and-line bottom fishing in shallow water; "kesokes," which consists of setting a net over a reef exit point at high tide and then catching the fish in the net on the falling tide as the fish head for deeper water; and trolling. The fish species that Palauans primarily target are surgeonfish, parrotfish, rabbitfish, and various snappers and groupers.

U.S. Withholds Fishing Privileges From Japan

On 6 April 1988, President Ronald Reagan reported to Congress his actions to encourage all nations to adhere to the conservation programs of the International Whaling Commission (IWC). Among those actions, the United States toughened its constraints against Japan for that country's whaling activities by withholding 100 percent of the directed fishing privileges that would otherwise be available to Japan in the U.S. Exclusive Economic Zone.

Last February, following confirmation that Japanese were killing minke whales in the Antarctic under a contested research whaling plan, Commerce Secretary C. William Verity notified the President—in a process called "certification"—that Japan's whaling was "diminishing the effectiveness" of the IWC's conservation program. The action, the strongest permitted by the Packwood-Magnuson Amendment to a Federal fishing law, denies Japan's request to harvest 3,000 metric tons of sea snails and 5,000 metric tons of Pacific whiting. In addition, Japan will be barred from any future allocations of any other fish, including Pacific cod, until the Secretary of Commerce determines the situation has been corrected.

Under a companion Federal Law, the Pelly Amendment, the President could have embargoed up to 100 percent of Japan's fishery products entering the United States. Instead, he asked the Secretary of Commerce and the Secretary of State to monitor Japan's whaling practices and report to him by 1 December, saying that a total withholding of Japan's directed fisheries allocation, coupled with a Presidential review, is the best means of encouraging Japan to conform with the IWC's conservation program.

U.S. Fines Japanese Vessels $150,000 for Illegal Fishing

Five Japanese vessels, accused by the United States of fishing illegally in U.S. waters off Alaska in mid-January, have agreed to pay the government penalties totaling $150,000, according to the National Oceanic and Atmospheric Administration (NOAA). In addition, the Commerce Department agency said it expects payment of a pentalty of $50,000 from a sixth vessel that was fishing illegally at the same time and had obscured its name. The penalties are the maximum possible under the Magnuson Fishery Conservation and Management Act.

NOAA said it is awaiting further information from the Japanese government about the identity of a seventh vessel that appears briefly in videotape footage provided by an Alaska fishermen's association. One of the vessel owners, Hamaya Suisan Co., will be denied permits for any of its vessels to fish in U.S. waters for 5 years, although the company will still be allowed to engage in joint ventures with American vessels. Two other companies, Taisei Gyogyo Co. and Senkon Gyogyo Co. will be denied fishing permits—including joint-venture permits—for their vessels for three years. In joint-venture operations, which last year resulted in a record 3.5-billion-pound-harvest, American fishermen sell their catch at sea to foreign processing boats. NOAA said that the Japanese government, which it characterized as being "extremely cooperative" in resolving the cases, has decided to levy sanctions of its own against the fishing vessels.

Eleven Indicted in Herring Conspiracy

An investigation by the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service and the State of Alaska has resulted in the indictments of 11 suspects for conspiracy to illegally harvest herring spawn on kelp and export it for sale in Japan. The secret indictments, made public earlier this year, charge the eleven-member ring, including fishermen, brokers, and foreign seafood wholesalers, with poaching at least $750,000 worth of the seafood delicacy off southeastern Alaska and trying to gain large profits by secretly transporting, selling, and exporting it in interstate and foreign commerce between 1985 and 1987.

Special agents from the Fisheries Service in Seattle and the Alaska Department of Public Safety made a joint raid of the operation on 10 April 1987, and arrested Tamdamitsu Sakurai, president of Hokkai Marine, Ltd., a large Japanese-Canadian seafood export business in British Columbia. He was charged with conspiracy to purchase and export the seafood and three counts of unlawful interstate transport of the herring spawn under the Federal Lacey Act. The indictments allege the group concealed its activity by obtaining a permit that allowed taking the herring spawn for personal use. After harvesting the spawn, it is alleged the suspects rented moving vans to transport the seafood to Seattle, where it was scheduled for shipment to Japan.

In February 1988, two other suspects entered guilty pleas before a federal judge in Alaska following indictments in the same case. Meanwhile, eight additional suspects, including three Seattle seafood brokers, are scheduled for similar prosecution for allegedly attempting to continue the illegal trade of the fish products after the main ring was broken.

Herring spawn on kelp, also known as gau or kazunokokombu, is a delicacy in Japan and other countries. The product is harvested by uprooting the seaweed immediately after herring lay their eggs on it. Since 1967, it has been illegal in Alaska to harvest is commercially. Its retail price ranges from $30 to $35 per pound. In addition to Sakurai, those indicted were Willis Hamilton, Donald Moore, and Henry Leask of Ketchikan, Alaska; Jim Frank, Byron Skinna, and Gideon Duncan of Hydaburg, Alaska; Lavina Grey, Grant Boe, and Lloyd Whaley of Seattle; and Steve Kinley of Ferndale, Wash.

Basic N.E. Fishery Data Now Available

Northeastern U.S. fisheries represent an important component of U.S. fisheries and have experienced many changes in recent years. Recent significant changes in management/regulations (i.e., ICNAF Management, MFCMA of 1976, the 1984 U.S.-Canada boundary settlement on the Gulf of Maine), in the status of biological stocks, and in fishing participation have occurred in the Northeast Region. Therefore, it is necessary to review these fisheries from an historical perspective to assist in understanding these changes. For this purpose, the NMFS Northeast Regional Office has put together a set of basic fisheries data in the form of charts and statistics. In this report, investment, landings, biological abundance, productivity, and costs and earnings are emphsized. Copies of the report are available from: NMFS, Northeast Fisheries Report, Analytical Services Branch, P.O. Box 1109, Gloucester, MA 01931-1109.

Lobster Tagging Program Set for 12-Mile Dumpsite

NMFS Northeast Fisheries Center scientists have begun a 2- to 3-year tagging program with lobsters from the 12-Mile Dumpsite in the New York Bight apex. The Dumpsite was recently closed and marine resource and environmental managers are watching for signs of recovery of the site's fisheries habitats. The recapture of lobsters that have been tagged and released in and around the Dumpsite should provide such information by detecting any changes in the direction and rate of lobster movements, as well as in the incidence and severity of lobster exoskeleton (shell) diseases.

Lobsters are being tagged with 1½-inch long, pink or yellow "spaghetti" tags which offer a reward. The reward is $3 plus the landed value of the lobster, and can be claimed by returning the tagged lobster to an NMFS port agent or the Center's Sandy Hook Laboratory in Highlands, N.J. "Short" (legally undersized) lobsters will be tagged, and possession of "shorts" by fishermen will only be permitted, provided that the tag remains in the lobster and is promptly returned to a NMFS port agent.

Gulf Red Drum Fishery Is Closed Indefinitely

The final rule implementing Amendment 2 to the Fishery Management Plan for the Red Drum Fishery in the Gulf of Mexico became effective on 29 June 1988. According to Joseph W. Angelovic, Acting Regional Director, National Marine Fisheries Service, Amendment 2 prohibits the harvest or possession of red drum in Federal waters until the adult population has been restored to levels that would safely allow the resumption of an offshore fishery.

Federal waters have been closed to the harvest of red drum since 1 January 1988 in response to stock analyses that indicated a distinct depression in the abundance of fish under 12 years of age. The scarcity of these age classes of red drum offshore has been attributed primarily to the excessive harvest of juveniles from state waters. Accordingly, states bordering the Gulf have been asked to increase the escapement of juvenile red drum to restore the offshore spawning stock to former levels of abundance. Those states are in various stages of revising their fishery laws to achieve the recommended 30 percent escapement rate of juveniles from the inshore and nearshore waters. Copies of the final rule may be obtained from the Fisheries Operations Branch, National Marine Fisheries Service, 9450 Koger Boulevard, St. Petersburg, FL 33702.

Court Okays Sea Turtle Safety Rules

Shrimp fishermen from Texas to North Carolina must use special TED devices or reduce their trawl times to prevent the drowning of sea turtles accidentally caught in their nets, following an order by the Fifth Circuit Court of Appeals, the National Oceanic and Atmospheric Administration (NOAA) announced. The Court's order, handed down 11 July in New Orleans, upholds Federal regulations mandating either turtle excluder devices (TED's) or reduced net towing times. The Court also said that as of 1 September it was lifting a lower court injunction that suspended the regulations while the case was being appealed.

The State of Louisiana and the Concerned Shrimpers of Louisiana had challenged the Federal rules in district court last year. James Brennan, head of NOAA's National Marine Fisheries Service said his agency was "ready, willing and able to help make TED's work most effectively for any shrimper. I don't believe there's a shrimp fisherman anywhere in the country who wants to see turtles killed," Brennan said. "It's up to all of us to see that turtles are protected and that shrimp fishermen can continue their work with a minimum of disruption."

Of the five species of sea turtles found off the U.S. coast, all are listed as threatened or endangered and are protected by Federal law. NOAA said that without TED's some 48,000 sea turtles would be caught in shrmpers' nets each year and that about 11,000 would die. Shrimp fishermen who fail to take the required steps to prevent turtles from being caught or drowned in their nets run the risk of being fined up to $10,000 under the Federal Endangered Species Act, NOAA said.

The effect of the court order is that shrimp trawlers of 25 feet and longer

will be required to use TED's when fishing in Gulf of Mexico or southwest Florida waters out to 15 n.mi. from shore and in the Cape Canaveral area of Florida. Boats under 25 feet must limit trawling time to 90 minutes in these waters. All vessels fishing for shrimp in inshore waters must limit trawl times to 90 minutes or use TED's. The dividing line between offshore and inshore waters is the COLREGS line found on 1:80,000 NOAA nautical charts. Staff at the Fisheries Service and at NOAA Sea Grant Offices will be available to help shrimpers find TED's and to assist in their installation and use. Information on TED suppliers is available from Charles A. Oravetz, NMFS, 9450 Koger Boulevard, St. Petersburg, FL 33702; (813/893-3366) or local Sea Grant Offices. TED gear specialists are at the Fisheries Service Pascagoula, MS, Laboratory (601/762-4591); Georgia Sea Grant (912/264-7268 and Texas Sea Grant (409/849-5711). Louisiana Sea Grant (504/388-6733) will soon have a gear specialist available.

A "Soft" TED Approved

Final regulations certifying a new soft Turtle Excluder Device (TED) for use by shrimp trawlers to conserve sea turtles became effective last October, according to Craig R. O'Connor, Acting Regional Director of the National Marine Fisheries Service (NMFS). Those regulations amended regulations published on 29 June 1987 that were designed to reduce the incidental catch and mortality of sea turtles in shrimp trawls. The 29 June 1987 regulations allowed the use of four types of TED's. They also contained a provision for qualification of new TED's if the TED's were tested according to procedures specified in the rule and found to be 97 percent effective in releasing sea turtles from trawls. This new TED, called the Morrison soft TED, was tested and found to be effective. For further details or copies of the regulations contact Charles Oravetz, NMFS, 9450 Koger Blvd., St. Petersburg, FL 33702, telephone (813) 893-3366.

TED Evaluation Program Underway

The National Marine Fisheries Service, in cooperation with the shrimp industry initiated a TED Evaluation Program on 5 March 1988. The overall objective of this program is to determine the effects of utilization of certified TED's on commercial shrimp trawlers in the South Atlantic and Gulf of Mexico. Specifically, the program is aimed at determining catch rates of shrimp for TED-equipped trawls and trawls without TED's in selected shrimp fishing areas of the southeast region. Observers will be placed on shrimp vessels operating off of Texas, Louisiana, Alabama, Mississippi, Florida, Georgia, and South Carolina. Catch per unit effort (CPUE) will be determined for trawls with and without TED's during peak months of the shrimping season. These data will then be analyzed using standard statistical procedures to determine whether there are or are not differences in catch rates between certified TED-equipped trawls and standard shrimp trawls without TED's.

Trained observers are available for work throughout the Gulf of Mexico and in the South Atlantic. Cooperation from the shrimping industry has been sought to place observers aboard vessels to help document the catch rates of shrimp nets equipped with TED's and standard nets. Assistance has been received from Sea Grant personnel throughout the Gulf of Mexico and South Atlantic, from the Texas, Louisiana, and South Carolina shrimp associations, and the Southeastern Fishery Association in locating vessels to use in this program. Gear specialists from Sea Grant (Texas) and from the NMFS Pascagoula Laboratory have been involved in tuning fishermen's nets with TED's. The South Atlantic Fishery Development Foundation is providing TED's and some additional funding for the program.

During June, four boat trips were made in Texas, two in Georgia, and one in Louisiana. In Texas, the efficiency of trawls equipped with Georgia TED's was comparable to that of standard trawls, and the TED's outproduced standard trawls on one trip. In Georgia, trawls equipped with Georgia TED's showed a slight increase in catch on one trip and a slight decrease in shrimp production during the second trip. A problem with the tickler chain occurred during the two which was responsible for the loss of shrimp by TED's. In Louisiana, both Georgia and Saunders TED's showed a high degree of shrimp loss in relation to standard trawls. Two Georgia TED's and one Saunders TED were severely damaged. Damaged TED's as well as clogging with debris were at least partially responsible for shrimp loss.

From the beginning of the study until about July, a total of 65 observer days have been expended on commercial vessels in the Gulf of Mexico and 10 days in Georgia. Two cruises had been completed in Key West, Fla, three from Freeport, Tex., two from Fourchon, La., and two from Brunswick, Ga. Trips were in progress at Aransas Pass and Brownsville, Tex. In general, the efficiency of TED's has varied on a trip by trip basis in a manner not unlike the results reported above. The continued cooperation of the shrimping industry in this program is appreciated.

Update: TED Rules Delayed

Rules mentioned above requiring use of Trawling Efficiency Devices have been delayed until 1 May 1989 for offshore waters and until 1 May 1990 for inshore waters.

A bill which was passed by the U.S. Congress reauthorizing the Endangered Species Act and signed by President Ronald Reagan on 7 October 1988 incorporated the TED rule delay.

The delay is effective in the southeastern United States except at Cape Canaveral, Fla., where TED's are required year round. For further information on the TED rule status, contact Charles Oravetz (telephone 813-893-3366).

The Fishery Exports of Latin America

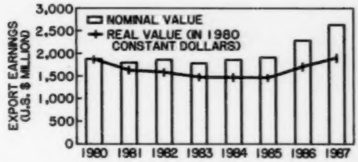


Figure 1.—Fishery export earnings of major Latin American fishing nations.

Several Latin American countries are important exporters of fishery products. Chile and Mexico are the two leading countries, both with exports exceeding $0.5 billion in 1987. Six other countries (Ecuador, Peru, Venezuela, Argentina, Brazil, and Cuba) export more than $0.1 billion annually (Table 1). The primary products for each country include: Chile (fish meal), Mexico (shrimp), Ecuador (shrimp), Peru (fish meal), Venezuela (tuna), Argentina (hake), Brazil (shrimp and lobster), and Cuba (lobster).

Most countries reported higher earnings in 1987, even though some countries reported catch declines, at least partially due to the 1986-87 El Niño event. Exports earnings have increased sharply in nominal dollars since 1980, but real earnings in constant 1980 dollars have increased only marginally. Declining real prices since 1980 for some of the region's primary export commodities (fish meal and shrimp) have limited real increases despite a major expansion of the fishing industry in the region. (Fish meal prices increased in 1987, but were still below 1980 levels in real dollars.)

Earnings Increase

Most countries reported sharply higher export earnings in 1987 relative to 1986 despite an overall decline in the regional fisheries catch. The leading exporters shipped $2.6 billion of fishery products in 1987, a 15 percent increase over the $2.2 billion shipped in 1986 (Figure 1, Table 1). Chile's export earnings increased by nearly $100 million despite a sharp decline in small pelagic catches. Improved fish meal prices and rising production in a variety of other fisheries enabled Chilean exporters to achieve record results (Table 1). Mexican export earnings increased by nearly $125 million because of near-record shrimp catches in their important Pacific coast fishery. Ecuador's export earnings increased by about $70 million because of massive increases in pond shrimp harvests. Ecuador replaced Mexico as the primary supplier of shrimp (in quantitative terms) to the United States. Peruvian earnings declined more than $20 million, as a result of lower fish meal production. Venezuelan exports declined nearly $50 million due to lower tuna shipments, based on official statistics. Actual results were probably better, as many Venezuelan tuna fishermen transship in Panama and other foreign ports, to avoid the undervalued official exchange rate, and do not report all of these shipments to the Venezuelan Government. According to some estimates, more than 50 percent of the Venezuelan tuna catch may have been transshipped illegally.

Argentina reported an export increase of nearly $85 million because of the strong market for hake and other groundfish in Europe and the United States. Brazil reported a $20 million increase, primarily because lobster shipments increased. Cuban 1987 data is unavailable.

Nominal Earnings Increase

Most major Latin American fishing countries have increased their nominal export earnings since 1980 (Table 1). Fishermen throughout the region have significantly expanded their catch since 1980. As a result, most countries have reported substantially increased exports, both in quantity and nominal value. The $2.6 billion worth of fishery products exported in 1987 was nearly 45 percent

Table 1.—Latin America's fishery export earnings by major fishing nation, 1980-87.

Nation	Export earnings (US$ million)							
	1980	1981	1982	1983	1984	1985	1986	1987
Chile	323.0	326.6	386.3	419.0	419.4	438.6	516.0	615.0
Mexico	580.0	494.5	396.2	436.8	437.4	371.0	423.9	550.0
Ecuador	200.0	188.8	219.6	219.4	216.1	260.9	383.6	450.0[1]
Argentina	143.3	139.4	190.6	168.2	157.7	149.9	183.0	267.3
Peru	320.6	298.8	282.3	145.4	233.2	221.6	256.1	235.0[1]
Brazil	132.8	155.9	161.6	137.3	179.3	174.3	153.8	175.5
Venezuela	4.9	12.4	24.1	55.4	80.4	127.8	188.5	140.0[1]
Cuba	123.8	120.2	146.3	157.5	84.3	118.0	123.1	N.A.[2]
Uruguay	50.9	61.3	47.5	45.7	48.9	54.1	65.2	82.8

[1]NMFS estimate.
[2]Not available.

Table 2.—Latin American fishery exports, by real value and major nation, 1980-87.

Nation	Fishery exports (US$ million[1])							
	1980	1981	1982	1983	1984	1985	1986	1987
Chile	323.0	296.2	329.9	346.5	332.6	336.0	387.5	445.9
Mexico	580.0	448.5	338.4	361.2	346.9	284.2	318.3	398.8
Ecuador	200.0	171.2	187.5	181.4	171.4	199.8	288.1	326.3[2]
Argentina	143.3	126.4	162.8	139.1	125.1	114.8	137.4	193.8
Peru	320.6	271.0	241.1	120.2	184.9	169.7	192.3	169.1
Brazil	132.8	141.4	138.0	113.5	142.2	133.5	115.5	127.2
Venezuela	4.9	11.2	20.6	45.8	63.8	97.9	141.6	101.5[2]
Cuba	123.8	109.0	124.9	130.3	66.8	90.4	92.4	N.A.[3]
Uruguay	50.9	55.6	40.6	37.8	38.8	41.4	49.0	60.0

[1]Values expressed in 1980 constant dollars. Annual figures were computed by using the following U.S. annual inflation rates: 1981, 10.3 percent; 1982, 6.2 percent; 1983, 3.2 percent; 1984, 4.3 percent; 1985, 3.6 percent; 1986, 1.9 percent; 1987, 3.6 percent.
[2]Estimate.
[3]Not available.

more than the $1.8 billion exported in 1980. Venezuelan and Ecuadorian earnings have more than doubled since 1980, while Chile and Argentina have reported increases of about 90 percent. Only Mexico and Peru have reported declines in nominal export earnings since 1980. Cuban earnings have changed little, although data is available only through 1986. Most of the increases in nominal earnings too place in 1986 and 1987 (Fig. 1). As recently as 1985 export earnings of the major countries totaled only $1.9 billion, only slightly ahead of 1980 exports (Table 1). The increase which began in 1986 is primarily due to the successful expansion of the pond shrimp industry in Ecuador and rising fish meal earnings. Chile, Peru, and Ecuador reported massive catch increases in 1986 and benefited from rising prices. Details on the continued expansion of export earnings in 1987 are discussed above.

Real Earnings Stable

Nominal export earnings, however, are misleading. The value of the U.S. dollar eroded substantially during the 1970's. Even during the 1980's, export trends show strikingly different patterns if earnings are calculated in constant 1980 dollars (Figure 1, Table 2). Inflation rates were particularly high in 1980 and 1981, but have been modest since 1984. During the 1980-87 period, the value of the dollar declined by nearly 30 percent. In constant 1980 dollars, four countries (Chile, Ecuador, Venezuela, and Argentina) have increased real export earnings since 1980. The aggregate fishery-export value of the region's major exporters has, however, changed little. Latin America's eight leading exporters shipped $1.83 billion worth of fishery products in 1980, but by 1987 shipments earned only $1.85 billion, less than a 2 percent increase. The major reason for the static pattern is that prices (in constant dollars) for some of the key products shipped by Latin American countries have declined since 1980. This is an unusual phenomenon as prices for many fishery products have increased along with—or in many cases at—rates in excess of inflation since 1980. Prices for Latin America's two most important export products (fish meal and shrimp), however, have fallen sharply in real value since 1980. As a result, major production increases by many countries have generated only modest—or even negative—increases in real earnings.

Government Roles

Latin American governments play varying roles in their fishing industries. Cuba and Nicaragua have industries entirely dominated by their governments. Mexico and Peru have mixed economies. The Mexican state fishing company plays a large role and controls much of Mexico's export marketing. Peru has several state fishing companies and dominates the fish meal industry. Both countries are currently reassessing their state companies because of growing budget deficits.

Some countries have no state fishing companies (Argentina, Brazil, and Chile). Some countries have modest fishery development programs, while others have sponsored major development efforts (Mexico and Brazil). Interestingly, the major export increases (Chile, Ecuador, Venezuela, and Argentina) have occurred in the countries with the lowest levels of government involvement in the fishing industry. Notably, the three countries which have reported declining or static export earnings (Cuba, Mexico, and Peru) are the countries in which the government plays the most significant role in the fishing industry.

Markets

Most Latin American countries (especially those shipping edible product) export the largest share of their seafood products to the United States. In many cases, shipments to the United States can total 90 percent or more of the country's total fishery exports. This is particularly true for the countries exporting high-valued shellfish. As a result, major exporters like Mexico, Ecuador, Venezuela, and Brazil are heavily dependent on the U.S. market.

There are some exceptions, however. Argentina has developed diverse markets for its seafood, and its shipments to Spain, Brazil, and Nigeria have frequently exceeded its U.S. shipments. Cuba is also an exception because the U.S. trade embargo prevents it from exporting to the United States. The market for fish meal and other inedible products is much more diverse than that for edible fishery products. The United States imports significant quantities, but Chile and Peru report sales to a wide variety of countries in Eastern and Western Europe and Asia. (Source: IFR-88/82.)

Sweden's Fish Catch Declines in 1986

Swedish fishermen harvested more than 200,000 t of fish and shellfish during 1986, an 11 percent decrease in quantity over the 1985 catch. Because of generally higher prices for fish in Western Europe during 1986, though, the value of Sweden's 1986 catch was higher than that of the 1985 catch. Meanwhile, seafood imports increased considerably to a new record of 86,900 t. Most of these imports originated from Denmark and Norway. At the same time, Sweden's fishery exports decreased dramatically, from 77,600 t in 1985 to 59,000 t in 1986. Sweden imported 3,600 t of fishery products from the United States in 1986, primarily salmon. Swedish purchases of U.S. crayfish, however, have shown a rapid growth, especially in 1987 when record exports are projected.

The U.S. Embassy in Stockholm has prepared a 31-page report reviewing Sweden's fishing industry. The report includes sections on catch and landings, foreign trade in fishery products, the size of the fishing fleet and number of fishermen, the market for crayfish, fish farming, market impediments, and information about the Swedish fisheries administration. The appendix includes statistical tables about Sweden's catch, by species, quantity, and value, Swedish fishery exports and imports by country and product, and Swedish aquaculture production. A listing of Swedish fisheries administrators is provided along with lists of fishery associations, importers, processors, and trade publications. The report also has a list of

Swedish and English fish names and a list of Swedish tariffs for imported fishery products. U.S. companies can obtain a copy of "Sweden's Fishing Industry, 1986" for $12.95 and a $3.00 handling fee (total of $15.95, personal checks or money orders only) by ordering report PB88-115530/GBA from NTIS, Springfield, Virginia 22161. (The handling fee is per order, regardless of how many reports are ordered.)

Chileans Culture Atlantic Salmon

Chile has one of the world's fastest growing salmon culture industries. Harvests totaled about 2,000 metric tons (t) in 1987, and many experts believe that Chilean production may reach 10,000 t by 1990. The country's full potential may exceed that of Norway. Chilean salmon farmers culture primarily the coho salmon, *Oncorhynchus kisutch*, while salmon farmers in most other important salmon producing countries culture primarily Atlantic salmon, *Salmo salar*.

Some foreign groups and local Chilean companies, however, are now establishing Atlantic salmon farms in Chile. Information is available on two such operations which could have a significant impact on the development of Chile's rapidly growing salmon culture industry. Atlantic salmon command higher prices because they can be grown to larger sizes than coho, and farms could significantly increase earnings by shifting some of their production to the Atlantic species. In addition, the foreign companies entering Chile are providing valuable technical and financial input that will promote the industry's development.

U.K. Joint Venture

The Chilean company, Lever Chile[1] (a subsidiary of Unilever), began operating an Atlantic salmon farm in 1987. Culture operations at the $10 million project are underway with an initial investment of $5 million. The General Director, David McCarthy, hopes that the project will produce 2,500 t of salmon a year by 1990, a figure which may eventually increase to 10,000 t. A team from Marine Harvest, a subsidiary of the giant British firm Unilever and a pioneer in Atlantic salmon culture, visited Chile in late 1986 and decided to initiate an Atlantic salmon project. Marine Harvest has operated salmon farms in Scotland for over 20 years and harvested 4,000 t of salmon in 1987. The experience and positive results gained there encouraged Marine Harvest to expand its operation abroad as potential new sites in Scotland are becoming scarce.

Lever Chile has imported salmon eggs from Scotland and constructed a hatchery near Lake Puyehue in Southern Chile. The imported eggs were hatched at the Puyehue facility. Some alevins have already been transferred to Lake Llanquihue, while the rest remained near Lake Puyehue. Lever Chile reports that their alevins were growing faster than the Marine Harvest alevins in Scotland, most likely because of higher water temperatures in Chile. Once the alevins mature to smolts they will be transferred to a marine-site southeast of Puerto Montt. Lever Chile estimates that the first Atlantic salmon will reach harvestable weight in 1990, although it could be earlier if the salmon continue to grow at the present rate.

The 2,500 t harvest projected in 1990 makes the Lever Chile project one of Chile's largest salmon farms. The projected Lever Chile harvest would be about 25 percent of Chile's projected salmon harvest in 1990. The technical and financial backing of Unilever provides Lever Chile support unavailable to most other Chilean salmon farms, many of which are relatively small operations.

Norwegian Joint Venture

The Swan Foundation, financed by the Norwegian Government, also started an Atlantic salmon culture project in Chile in 1986. Swan not only plans to culture salmon itself, but to sell both eggs and smolts. It could thus help many small operations in Chile to shift from coho to Atlantic salmon culture if they so desire. The size of the project and projected production of Swan, however, are unavailable.

Several Chilean companies also plan to work with Atlantic salmon. Three companies (Chisal, Pesqueras Mares Australes, and Soc. Agricola Aguas Claras) plan to culture Atlantic salmon. Some projects have already been initiated. Other Chilean companies plan to produce eggs and smolts for sale to farmers. Domestic production of Atlantic salmon smolts and eggs will help avoid dependence on foreign suppliers and the transmission of diseases. (Source: IFR-88/25.)

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Population Biology Symposium Slated

An International Symposium on Fish Population Biology has been scheduled for 17-21 July 1989 at the University of Aberdeen, Scotland, by the Fisheries Society of the British Isles in collaboration with the Marine Laboratory of the Department of Agriculture and Fisheries for Scotland. The meetings will provide an opportunity to explore the complex relationships that determine the biological state of fish populations, the organizers report, and the biology of both marine and freshwater species will be covered. Topics will include theories of fish population dynamics and stock assessment science and methodology, larval ecology and juvenile life history (relevant to recruitment to the adult population), fish stock identification and distribution, migrations, and regional variation of life history parameters, reproductive biology (in relation to genetics, growth and food availability, and much more.

For further information contact D. N. MacLennan, DAFS Marine Laboratory, P.O. Box 101, Victoria Road, Aberdeen, Scotland, AB9 8DB.

Norway Scientists to Increase Whale Research

The Norwegian Government has approved a whale research program for 1988-92 which represents a substantial increase in Norwegian whale research.

The main purpose of the program is to work out data and guidelines providing for reasonable preservation and management of the whale population in the northeast Atlantic Ocean, at a time when the mutual dependency between whales, other marine mammals and fish populations is being evaluated, reports the Norwegian Information Service, Norinform.

The main goals of the Norwegian program are: 1) To ascertain if there are separate populations of minke whales in the North Atlantic, and if so gauge their interaction, 2) to map the minke whale's pattern of migration, 3) to gain a more precise estimate of the minke whale population and increase knowledge of other important factors that affect the whale population, and 4) to determine the important of the minke whale population to the ecological system in the Norwegian Sea and Barents Sea.

The program is meant as Norway's contribution to the comprehensive whale population study being carried out under the auspices of the International Whaling Commission. To carry out its program this year, Norway plans to harvest 35 minke whales this summer. But at the annual meeting of the IWC held in New Zealand in the beginning of June, Norway won no support for its research harvest quota. At the meeting, a resolution forwarded by Australia expressing doubts over the scientific basis of the plan was passed by the commission by a 14 to 4 vote, with 10 countries abstaining.

Budgeting for Fish and Fisheries in Japan

The Fisheries Agency of Japan's (FAJ) budget for fiscal year (FY) 1988, which began on 1 April 1988, was authorized at ¥329 billion (about US$2.6 billion at the then current exchange rate). Japan's fiscal year runs from 1 April to 31 March of the next year. The exchange rates used in this report are ¥140 per US dollar for FY 1987 and ¥125 per US dollar for FY 1988. All references to FY in this report refer to Japanese Fiscal Year(s).

The FY 1988 fisheries budget was 11 percent higher than the FY 1987 fisheries budget of ¥301 billion ($2.1 billion). The 1988 budget, while 11 percent higher than the FY 1987 budget in yen terms, is almost 24 percent greater in terms of the U.S. dollar, which depreciated considerably during 1987 and early 1988. The FAJ budget accounts for about 0.6 percent of Japan's total national budget.

The 1988 fisheries budget is the largest in Japan's history, surpassing the previous record budget of ¥317 billion in FY 1982. The FAJ originally requested ¥328 billion for FY 1988, but because of a windfall of funds obtained from the privatization of the Government-owned Nippon Telephone and Telegraph (NTT), amounting to over ¥34 billion ($272 million), the final amount was actually larger than that requested (see box).

Nippon Telephone and Telegraph Privatization

The 1987 privatization of NTT made over ¥1.3 trillion ($11 billion) available to the Japanese Government for FY 1988. This money was to be expended in the form of interest-free loans for three different types of projects:

1) *NTT Type A Projects:* A total of ¥200 billion is earmarked for 20 year loans for public works that are expected to earn a profit. The loans will be repaid with the profits accrued from these projects and a 5-year grace period will be allowed before repayment must begin.

2) *NTT Type B Projects:* About ¥1 trillion will be available for non-profit public work projects in the form of 10-year loans with 3-year repayment grace periods.

3) *NTT Type C Projects:* A total of ¥100 billion will be made available to the private companies at 15-year loans with 3-year repayment grace periods. This money must be used for projects which contribute to the enhancement of the national economy.

Note: Only ¥34 billion (US$272 million) of the total available NTT funds (or about 2.5 percent) will be used for fishery projects.

Background

The FAJ's "General Accounts" budget consists of a "public" expenditures budget and a "nonpublic" expenditures budget (Table 1). It is often difficult to distinguish between the two types.

"Public" expenditures are monies spent for activities involving the national government directly. In a nonfishery setting, this would include such projects as road, sewer, and power plant construction (i.e., "social infrastructure" projects). In Japan, government "public" expenditures are used as economic stimuli. The fisheries "public" budget includes fishing port maintenance, shoreline preservation, and coastal fisheries promotion. Most "public" budget items are politically sensitive and it is usually very difficult to reduce spending for programs in this category.

"Nonpublic" expenditures are program oriented. Prefectural and city governments, as well as associations and private companies, share the cost of nonpublic programs with Japan's national government—often up to 50 percent. These projects are also administered by local governments and other bodies. There is some overlap between the public and nonpublic accounts. Decisions as to which account a program is assigned often depends on the national government's financial situation during the budgeting process. If national government coffers are full, both public and nonpublic accounts may benefit, but

Table 1.—Budget of the Fisheries Agency of Japan by item, year, and percent change, for 1987 and 1988.

Budgetary item	Amount and FY[1] 1987	Amount and FY[1] 1988	Percent change
General accounts			
Public expenditures			
Fishing ports	156,928	185,371	+18
Coastal fishing grounds maintenance	20,722	24,670	+19
Shoreline preservation	11,911	14,044	+18
NIT Type A projects (1988 only)		678	
Disaster rehabilitation	790	1,226	+55
Subtotal	190,351	225,989	+19
Nonpublic expenditures			
Domestic fisheries promotion			
Master plan for promotion		31	
Coastal fisheries improvement	7,006	6,748	−4
Development of new technology	838	1,046	+25
Fish farming	4,229	4,381	+4
Salmon release program	3,152	3,014	−4
Aquaculture	69	347	+402
Development of offshore grounds	133	309	+132
Resources management-minded fisheries	156	472	+203
Inland fisheries promotion	874	868	negl.
Fishery coordination councils	871	835	−4
Fishery resources conservation	114	111	−3
Fisheries extension			
Fisheries extension	981	986	negl.
Coastal fisheries improvement	553	480	−13
(Loan parameters)	(5,300)	(5,300)	
Fishermen's welfare	261	246	−6
Subtotal	19,237	19,874	+4
Fisheries management			
Production restructuring			
Special programs	4,000	3,800	−5
Fisheries restructuring fund	2,357	2,081	−12
(Loan parameters)	(60,000)	(60,000)	
Subtotal	6,357	5,881	−7
Emergency loans			
Management reconstruction fund	954	1,027	+8
(Loan parameters)	(30,000)	(30,000)	
Management stability fund	1,844	1,409	−24
(Loan parameters)	(37,000)	(37,000)	
International regulatory fund	910	883	−3
(Loan parameters)	(13,000)	(13,000)	
Fisheries fuel oil fund	1,065	321	−70
Subtotal	4,773	3,640	−24
Small fisheries loan guarantees	5,450	4,660	−14
Fishery cooperatives	702	889	+27
Fisheries modernization fund	3,831	3,403	−11
(Loan parameters)	(125,000)	(125,000)	
MAFF Public Finance Corp. fund[2]			
(Loan parameters)	(95,000)	(87,600)	(−8)
Subtotal	21,112	18,474	−12
Fishery products consumption, pricing, marketing and processing			
Consumption expansion	568	453	−20
Price stabilization	1,381	1,794	+30
Processing improvements			
Marketing depot construction	1,584	1,516	−4
Processing facilities fund	55	47	−15
Fishery products consumption (continued)			
(Loan parameters)	(5,900)	(7,500)	(+27)
Processing management			
Promotion fund	263	247	−27
(Loan parameters)	(14,000)	(14,000)	
Other	33	13	−61
Subtotal (Proc. Impr.)	1,935	1,823	−6
Subtotal	3,884	4,070	+5
Resource development and access to foreign fisheries			
Marine Resources Development			
JAMARC[3]	4,942	4,758	−4
Other	438	425	−3
Subtotal	5,380	5,183	−4
Foreign fisheries cooperation			
International fisheries cooperation	4,000	4,000	
Foreign 200-mile zone development	126	207	+64
Foreign ministry aid	9,700	10,000	+3
International federation of cooperatives	21	18	−14
South Pacific aquaculture	65	54	−17
South Pacific coastal fisheries		143	
Other	365	366	negl.
Subtotal	14,277	14,788	+4
Access to foreign fishing grounds			
Resource surveys			
Fisheries resources survey[4]	1,068	957	−10
North Pacific living resources	647	630	−3
Distant water living resources	224	217	−3
Marine debris	24	52	+117
Scientific whaling	355	515	+45
Other surveys	72	40	−44
Subtotal	2,390	2,411	+1
Subtotal	22,231	22,563	+1
Other			
Fishery compensation system			
Fisheries disaster compensation	8,113	7,842	−3
Vessel loss compensation	6,995	7,103	+2
Subtotal	15,108	14,945	−1
Fishery environmental protection	1,665	1,728	+4
Fish diseases research	285	357	+25
Fisheries enforcement	5,805	6,226	+7
Regional improvement measures	1,615	1,421	−12
Measures for fishing vessels	213	158	−26
Fisheries research	5,810	5,894	+1
Other, nonspecified items	8,216	7,645	−7
Subtotal	38,717	38,374	−1
Subtotal, nonpublic expenditures	105,181	103,355	−2
Total, general accounts	295,532	329,344	+11
Special account			
Fishing vessel reinsurance and Fisheries mutual insurance	39,206	38,098	−3

[1]Fiscal year is from 1 April to 31 March; amounts are given in millions of yen.
[2]Funds for this item are not from the FAJ budget.
[3]JAMARC: Japan Marine Fishery Resources Research Center.
[4]The Fisheries Resources Survey (¥957 million for FY 1988) includes ¥61 million for southern bluefin tuna stock recruitment monitoring.

if the national government's financial situation is not so good, local governments may end up contributing a greater percentage of project funding.

The FAJ has placed greater emphasis on public spending in the FY 1988 budget. The public fisheries budget is about 69 percent of the entire FAJ general account budget for FY 1988. The FAJ public fisheries budget increased by 19 percent from the FY 1987 budget, from ¥190 billion to ¥226 billion,

while the nonpublic budget decreased by about 2 percent, from ¥105 billion to ¥103 billion.

Public Expenditures

Several new 6-year plans began under Japan's public expenditures category in 1988. These include the "8th Long-Term Ports Maintenance Plan" (with a 6-year total budget of ¥2.4 trillion), the "3rd Coastal Fisheries Maintenance and Development Plan" (with a 6-year total budget of ¥480 billion), and the "New Coastal Fisheries Organization Improvement Plan, Second Period" (with a 6-year total budget of ¥100 billion).

Public Sector Fishing Port Projects

Over half ($1.5 billion) of the entire fisheries budget will be spent on fishing ports. The "8th Long-Term Fishing Ports Maintenance Plan", like its predecessor, will stress the need for ports to adapt to the changing environment affecting Japan's fishing industry, emphasize the more efficient use of marine resources, establish an effective marketing and processing organization in response to the new information age, and ensure the vitality of fishing villages. Originally, a 6-year budget of ¥2.8 trillion was requested for the 8th Plan, but only ¥2.4 trillion was approved—still 14 percent greater than the ¥2.1 trillion allocated in the 7th plan. The FY 1988 budget provides approximately ¥185 billion for the first year of the 8th Plan. Of this amount, NIT Type B funds accounted for ¥28.2 billion.

Coastal Fishing Grounds Maintenance

The 6-year "2nd Coastal Fisheries Maintenance and Development Plan" ended in 1987 and will be succeeded by the 3rd Plan, also a 6-year program. Its goals are to organize the coastal fisheries infrastructure—specifically to maintain and promote coastal fisheries through the introduction of new technology. The 3rd Plan will receive ¥24.7 billion in 1988, ¥3.9 billion of which will come from NIT Type B funds. Notable programs under the 3rd Plan include: 1) A ¥115 million plan to introduce new marine ranching technology, called the "Program for the Introduction of an Extensive-Use System in Coastal Waters"; 2) a ¥160 million program called the "Program for Efficient Use of Coastal Fisheries"; and 3) a ¥50 million study on the maintenance and development of existing coastal fisheries, as well as the development of new ones.

NIT Type A and B Projects

The FY 1988 FAJ budget earmarked ¥678 million in NIT Type A funds for expanding the use of fishing ports. One aspect of this program entails building dikes to prevent shoreline erosion, then building and selling houses on the stabilized shoreline. Some specific NIT Type B projects include the "Emergency Plan to Vitalize Fishing Village Fisheries", and the "Resort Area-Fishing Port Utilization Promotion Project." Both of these projects fall under the Fishing Ports, Coastal Fishing Grounds Maintenance, and Shoreline Preservation categories of the public account.

Nonpublic Expenditures

Domestic Fisheries Promotion

Promotion Master Plan

A new fisheries promotion master plan, called the "Project for General Development and Maintenance of Coastal and Inland Areas", was funded at ¥31 million for FY 1988. The plan, part of Japan's "Marinovation" Program, involves the development of 40 sites. "Marinovation 21" (Marine Innovation for the 21st Century) is one part of a concept developed by the FAJ in 1986 to more effectively utilize fishery resources within Japan's 200-mile zone. The ultimate goal of the program is self-sufficiency in the production of seafood. In 1986, the FAJ established a foundation, "Marino-Forum 21", to coordinate industry-government activities. "Marino-Forum 21" has been focusing on marine aquaculture and ranching, construction of artificial reefs and fish aggregating devices to boost fisheries production, and "marinovation," the introduction of new technology to fishing villages to increase productivity.

Coastal Fisheries Improvement

This program was modified for FY 1988 in response to the changing conditions affecting Japanese fishermen. The new 6-year program, called the "Second-Phase Coastal Fisheries Improvement Program", has a total 6-year budget of ¥100 billion ($800 million). This program consists of the "Basic Coastal Fisheries Structural Improvement Program" (involving 86 specific locations) and the "Prefectural Coastal Fisheries Structural Improvement Plan" (involving 39 locations) and will receive funds amounting to ¥6.7 billion in the FY 1988 budget. It is presumed that the fund allocation will escalate in the next 5 years.

Development of New Technology

Several new projects concerning the development of energy-saving devices wll be funded in 1988. A new unmanned lighthouse will be developed with ¥16 million as a result of the 1987 Japan-ROK fishery negotiations. The 1988 budget also provides ¥16 million for the development of live fish shipment methods for Japanese trawlers. Finally, ¥51 million has been allocated to the new "Advanced Technology Development Plan". Additional information is not available.

Fish Farming and Salmon Release Programs

The "Plan to Develop Technology for the Increase of Regionally Cultured Species" is another new program funded under the 1988 budget. The project, which will receive ¥92 million in FY 1988, is designed to develop high-valued marine resources such as salmon to meet Japan's increasing demand for high-quality and diversified fishery products. A new study for the improvement of the quality of hatchery salmon, particularly coho salmon, will be funded at ¥13 million. The total funding for the fish farming and salmon release programs is ¥7.4 billion.

Aquaculture

Aquaculture projects received ¥347

million (2.8 million) in FY 1988, more than five times the funding they received in FY 1987. Several new programs bear mentioning: 1) The "Plan to Promote the Management of Fish Aquaculture," which is a program to build leadership and joint aquaculture management in fishery cooperatives; 2) the "Coastal Aquaculture System Technology Development Plan," a project also associated with Marino-Forum 21; and 3) a study to determine the effect of rot-resistant nets on shellfish.

Inland Fisheries Promotion

Of the total budget of ¥868 million, the "Basic Study on the Maintenance and Development of Inland Fisheries" has been granted ¥180 million. The Japan Marine Products Resource Development Center (JAMARC) is involved with this project.

Resource Management Promotion

The 1988 budget provides ¥472 million in resource management funds, three times the level of the previous year. Resource management projects include: 1) The "Program to Promote Aquaculture and Management Policy," a ¥360 million plan to improve fishery resource management by fishermen; 2) the "Experiment to Develop Technology for the Improvement of Long-Range Forecasts," a ¥12 million project to build a data base for a planned Fisheries Information Service Center; and 3) the "Coastal Fisheries Resource Management Improvement Fund," a program with "loan parameters" of ¥5 billion, to provide the financing for resource management implementation. The term "loan parameters," as used here, refers to a ceiling on a system of revolving loans for various budget items. The funds are usually reloaned after repayment. An expansion of the parameter means the addition of new money, while a reduction indicates a net return of funds to the system. In Table 1, the numbers in brackets following the heading "loan parameters" are not included in the budget total, but indicate the cumulative totals available for lending.

Several private-sector fisheries promotion projects (those designed to encourage private entrepreneurship) will be funded by NIT Type C funds (see box). These include 1) the "Fisheries Related Research Development—Maintenance of the Business Structure," 2) "Project to Increase the Use of Fishery Ports," and 3) the "Maintenance of Open Areas in Ports." However, the implementation of these plans is on hold pending the revision of Japan's Privatization Law.

Fisheries Management

Production Restructuring and Emergency Loans

The "Fisheries Restructuring and Maintenance Fund," loan parameters of ¥60 billion; the "Fisheries Management Reconstruction Fund," loan parameters of ¥30 billion; the "Fisheries Management Stability Fund," loan parameters of ¥37 billion; the "International Regulatory Management Stabilization Fund," loan parameters of ¥13 billion; and the "Fisheries Modernization Fund," loan parameters of ¥125 billion), all remain unchanged from 1987. Loan parameters for the "Ministry of Agriculture, Forestry and Fisheries Public Finance Corporation Fund" decreased by about 8 percent from those of 1987.

Fishery Cooperatives

The "Interest Subsidy Program" for the "Fishery Cooperatives Trust Fund," received a 2-year extension. Interest subsidy funds will about to ¥20 billion for FY 1988. The commercial interest rate is 3 percent, but the preferential interest rate for fishery cooperatives is 2 percent.

Fishery Products Promotion

The "General Plan for Marine Products Distribution and Processing", which expired at the end of FY 1987, will be continued in 1988 as the "Marine Products Central Distribution and Processing Structure Maintenance Plan", with a budget of ¥1.5 billion. In addition, a 5-year extension was granted to the "Fisheries Processing Facilities Fund" (which expired in March 1988). The loan parameters for this fund have been raised from ¥5.9 billion to ¥7.5 billion. Finally, last year's "Fish Products Processing Management Improvement Program" was renamed the "Fish Products Processing Management Promotion Fund" and allocated loan parameters of ¥14 billion.

Resource Development and Access to Foreign Fisheries

The "Resource Development and Access to Foreign Fisheries" budget category of the 1988 "nonpublic" fisheries budget increased by almost 2 percent, from ¥22.2 billion in FY 1987 to ¥22.6 billion. A decrease in spending for marine resources development and access to foreign fishing grounds was offset by an increase in the budget for foreign fisheries cooperation and resource surveys.

Marine Resources Development

The FY 1988 budget for the Japan Marine Fishery Resource Research Center (JAMARC), a semi-governmental organization set up to develop and exploit underutilized marine fishery resources, decreased by 4 percent from the 1987 fisheries budget. The overall marine resources development budget declined by 4 percent in FY 1988.

Foreign Fisheries Cooperation

To promote international fisheries cooperation, the 1988 government budget provides a 4 percent increase. This will bring its funding to nearly ¥15 billion. A new program to promote the coastal fisheries of South Pacific nations will be funded at ¥142 million under this portion of the budget.

Resource Surveys

Of the total budget of ¥2.4 billion earmarked for resource surveys in FY 1988, the Japanese will spend ¥61 million to determine the trends in southern bluefin tuna resources being harvested by Australia, New Zealand, and Japan. Japanese scientists will also study the effect of driftnets on marine mammals, a problem central to the North Pacific area, and the effect of persistent marine debris on marine life. Scientific whaling, a new budget item in FY 1987, was increased by 45 percent from ¥355

million ($2.5 million) to ¥515 million ($4.1 million) in 1988.

Other Programs

Other programs awarded budget increases in FY 1988 are the "Fishery Environmental Protection Program," the "Fish Diseases Research Program," and the "Fisheries Enforcement Program." Under the "Fishery Environment Protection Programs," the "Aquaculture Program" and the "Harmful Chemicals and Fishery Study" will be combined and funded at ¥81 million. Fisheries enforcement funding will be ¥6.2 billion, a 7 percent increase from 1987, primarily because the Japanese will require an additional enforcement vessel to implement the 1988 Japan-Republic of Korea fisheries agreement. (Source: IFR-88/60, prepared by Paul E. Niemeier and Richard Walsh of the NMFS Foreign Fisheries Analysis Branch (F/IA23) in Washington, D.C.)

MEXICO'S SEA TURTLE PROGRAM

The Mexican Government is concerned about sea turtle stocks off both its Pacific and Gulf coasts. Six of the world's seven species of sea turtles nest on Mexican beaches (Table 1). The Government has prohibited the capture of all sea turtles except for the Pacific ridley, which cooperative fishermen in the States of Oaxaca, Michoacan, and Guerrero are allowed to take in controlled numbers. Cooperative fishermen in those states have asked the Secretariat of Fisheries (SEPESCA) to increase the number of permits issued for the taking of turtles, but SEPESCA, as part of President Miguel de La Madrid's "100 Actions Program" to protect endangered species, has refused. Only 19 cooperatives in all of Mexico (9 in Oaxaca) were allowed to take turtles in 1987, the same number of cooperatives that had permits in 1986.

The Government has also intensified its efforts to protect turtles. Penalties for illegal turtle fishing have been increased; fines may be levied of up to 1 million pesos (US$1 = 1,400 pesos in summer 1987). SEPESCA, the Secretariat of Urban Development and Ecology (SEDUE), and the Navy, as well as several university groups, are cooperating in efforts to protect and study marine turtles. Mexican newspapers have dealt with the results of these efforts and have reported on the status of turtles in several different Mexican states.

Table 1.—Glossary of Mexican sea turtles.

English name	Spanish name	Scientific name
Ridley, Atlantic	Lora	*Lepidochelys olivacea*
Hawksbill, Pacific	Golfina Carey/amarilla	*L. kempi* *Eritmochelys imbricata*
Green	Blanca/prieta/verde	*Chelonia mydas*
Leatherback	Laud	*Dermochelys coriacea*
Loggerhead	Mestiza/cabullera	*Caretta caretta*

Gulf Coast Turtles

Tamaulipas

Mexico's Rancho Nuevo preserve located in the State of Tamaulipas is the only concentrated natural nesting ground left for the Kemp's ridley turtle, although sporadic nesting occurs from Veracruz to Padre Island in Texas. As many as 95 percent of nesting Kemp's ridleys do so at Rancho Nuevo. SEPESCA reported that 715 Kemp's ridley sea turtle nests

Table 2.—Mexican sea turtle catch, 1980-86.

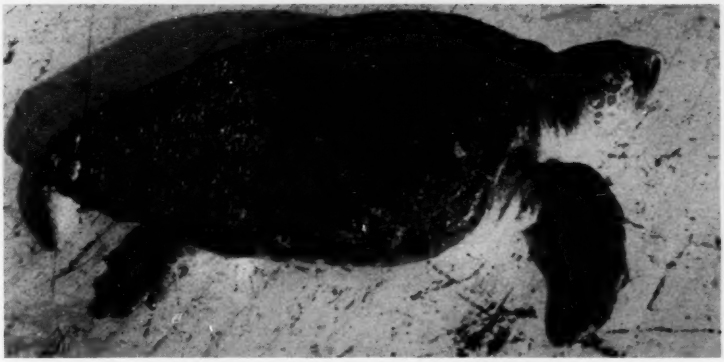
	Catch in metric tons						
State	1980	1981	1982	1983	1984	1985[1]	1986[1]
Gulf of Mexico							
Campeche			163	1,585[2]	1,055		
Tabasco	28	42	53	39	61		
Quintana Roo	19			1	8		
Veracruz					1		
Tamaulipas				3			
Yucatan							
Subtotal[3]	47	42	216	1,628	1,125		
Pacific Ocean							
Oaxaca	1,623	2,129	2,063	1,051	897		
Michoacan	452	133	130	113	76		
Chiapas				22	22		
Nayarit	93	41	11	13	9		
Sinaloa		103	21	12	7		
Baja Calif.					6		
Guerrero	112	169	167	20	1		
Baja Calif. Sur			208	56	1		
Jalisco			20	2			
Colima				1			
Subtotal[3]	2,280	2,575	2,620	1,290	1,019		
Total[3]	2,447	2,610	2,863	2,918	2,144	1,682	986

[1]Only grand total data available.
[2]The large catch increase reported by SEPESCA is unexplained, but may be due to changes in statistical record keeping.
[3]The regional subtotal and total statistics do not match those divided by state. The discrepancy is unexplained.

were spotted at the Rancho Nuevo preserve by the end of July 1987. The number is about the same as has been reported in recent years at Rancho Nuevo.

Ernesto Coripio Cadena, former Director of the Instituto Nacional de Pesca's (INP) research center at Veracruz (currently the SEPESCA Tamaulipas Agent), warned that the major natural nesting ground of the Kemp's ridley has been reduced to only a 20 km stretch along the Tamaulipas coast. Coripio charged that legal fishing (incidental turtle catches by shrimp trawlers) and natural predators are the principal causes of the Kemp's ridley decline. He also stated that the INP has arranged for armed military (Navy) patrols to protect nesting females along the 20 km beach area. Since 1978, according to INP biologists Rene Marquez and Manual Sanchez, about 500,000 turtle hatchlings have been released along the Tamaulipas coast. The scientists claim that when they relocate the eggs from the beach to nests within protected corrals, they increase the number of eggs that hatch by about 70 percent. No reliable method, however, has been established to study the turtle's survivability once the hatchlings have been released.

In April 1987 Coripio outlined SEPESCA's 1987 protection plans. SEPESCA planned to release 50,000 hatchlings and mark as many as 200 adult turtles as part of a joint turtle study with the United States. The 1987 plan was similar to previous annual work plans. The study also included incubation, migration (some individuals have been radio-tagged), and nesting. Mexico provides the United States with about 2,000 Kemp's ridley eggs annually to develop a nesting population on Padre Island in Texas. The exchange is called the "Head Start program". Hatchlings are raised in captivity for about 1 year and then released. Mexico and the United States are also cooperating in a program designed to evaluate turtle excluder devices (TED's) on shrimp trawlers.



Loggerhead sea turtle. Photo by Larry Ogren.

Campeche

Campeche has the largest population of nesting hawksbills along the Gulf of Mexico. Juan Jose Perex Palma, SEDUE Campeche agent, believes that recent regulations curtailing sand removal from the coastal beaches will be beneficial for the reproduction of hawksbill turtles which nest on the state's beaches. Previously, large-scale sand removal (for unspecified reasons) had destroyed thousands of turtle eggs. The Mexican Government, through both SEDUE and SEPESCA, plans to invest about 30 million pesos for a turtle protection camp at Sabancuy near Champoton. The camp will be guarded and consists of incubators, growout centers, and corrals. Scientists will collect eggs from nests and incubate them to prevent destruction by predators and poachers. SEPESCA and SEDUE plan to protect 150 nests and 25,000 eggs annually.

Yucatan

Yucatan is also protecting endangered sea turtles. Juan Jose Perez Palma, SEDUE agent, announced plans to create a turtle reserve at Isla Aguada off the Yucatan coast. Although no details are available, projects are underway to protect both the hawksbills and green turtles. Even so, stuffed turtles and turtle jewelry are prominently displayed in shops throughout Yucatan (as well as in Quintana Roo and Campeche).

Caribbean Coast: Quintana Roo

Illegal turtle harvesting is reportedly a common practice in Quintana Roo. In Isla Mujeres, Cancun, and Cozumel (popular tourist resorts where wild turtles used to be attractions) the beaches rarely report wild turtles and tourists can now only observe them in pens.

Pacific Coast

Chiapas

Humberto Hernandez Ruiz, Tonala (Chiapas) cooperative fishermen's representative, has charged that turtle eggs are being taken illegally and transported to restaurants in the nearby city of Tuxtla Gutierrez. Hernandez asked that the state government assist SEPESCA in protecting and stopping the illegal flow of eggs with stricter enforcement and heavier fines.

Oaxaca

Oaxaca has the largest population of nesting turtles along the Pacific coast of Mexico. In July 1987, 30,000 Pacific ridleys reportedly arrived to nest on the La Escobilla beach. Oaxaca is one of the three states in Mexico which allows a limited number of turtles to be taken. The 1987 quota for the nine cooperatives allowed to take turtles was 23,000-24,000 turtles. The State planned to spend 25 million pesos on its turtle conservation program in 1987. Oaxaca has turtle observation and protection camps at Escobilla, Palmerito, and Chacagua. Officials report that at La Escobilla beach alone 7 million hatchlings have been released and 2,000 turtles had been marked since the beginning of 1987.

Oaxaca also has a slaughterhouse program in which eggs are taken from the

slaughtered female and incubated. In 1987, about 350,000 hatchlings were released from that program. SEPESCA, the state government, fishery cooperatives, various conservation groups, and universities are involved in both programs. The nine Oaxaca-based fishing cooperatives charged in a 1987 proclamation that foreign interests, "ignorant of Mexican socio-economic reality" were trying to influence Mexico's policy on sea turtle protection which the cooperatives believe is adequate. The fishermen claim that SEPSCA's management program has protected the turtle population, and believe that the stocks have increased rather than decreased. The fishermen claim that the Pacific ridleys are an important source of food and employment for the cooperatives.

Michoacan

The Universidad Michoacana (UM) reports releasing 280,000 hatchlings along the Michoacan coast during the 1986-87 turtle reproductive cycle. Other agencies are reportedly active in the protection program, including SEPESCA and SEDUE. There seems to be some disagreement, however, between agencies over their respective roles. (Officially, SEPESCA grants fishing permits and SEDUE is responsible for endangered species protection.) Ramiro Sanchez Perez of the UM Biology Department, objects to the SEDUE program and charges that SEDUE should not be officially involved in turtle protection. Sanchez stated that SEPESCA and the UM are collaborating on a protection plan by marking 500 turtles for study and increasing nest surveillance. The Navy conducts armed patrols to protect the nests. The protection program is centered around the green turtle and the leatherback, but includes Pacific ridleys. Michoacan has turtle camps at Colola, Marauata, San Telmo, Chimapa, El Salado, Chiquiapan, Calabezas, Santa Ana, and Mexiquillo.

Colima

Francesco Perez Sarabia, SEDUE Regional Officer, stated that SEDUE planned to set up two turtle protection teams on the Chupadero and Playa de Oro beaches in Colima. The teams were to observe the loggerhead turtle nests for study and guard them from illegal poachers during the nesting season which ends in December. The teams were also to collect eggs, incubate them, allow them to grow, and then release them. Each team consists of technicians, patrols, and students from nearby universities. SEPESCA provides technical assistance. The Mexican Army planned to set up checkpoints on the borders with Jalisco and Michoacan to contain the contraband trade. The Navy was also to provide offshore patrols near the nesting grounds. Fishery cooperatives provided food and basic necessities to the teams.

Jalisco

SEPESCA hopes to release 50,000 turtle hatchlings in 1987 through a project coordinated by the Universidad de Guadalajara (UG), SEDUE, and the Navy. SEPESCA had originally planned to release 100,000 hatchlings but could not collect sufficient eggs. SEPESCA also planned to protect at least 1,000 turtle nests along the Jalisco coast. There are seven protection camps at Mismaloya, Tecuan, Teopa, and Tomatlan along the Jalisco coast. Maurilio Soto Esparza, SEPESCA Regional Agent, stated that the turtle protection program can only work if the socioeconomic condition of the local fishermen is taken into account. Because of unemployment, underemployment, and low incomes, fishermen take advantage of whatever resource is available, including turtle poaching. About 70 people were arrested for turtle poaching in 1986, and 17 of them were fined a total of 300,000 pesos.

Nayarit

Although SEPESCA does not permit the taking of marine turtles in Nayarit, poachers reportedly take them all along the Nayarit coastline, and then ship them to Tepic, Guadalajara, and Mexico City for quick profit. The Director of the Centros Tecnologicos del Mar, Ignacio Carillo Diaz, has charged that the regulations protecting the turtles were not being enforced. He stated that turtles were often sold openly along the beaches, and that the practice is so widespread and accepted that the price for turtle meat is below that for beef. Information corroborating these charges is not available.

Sinaloa

One small turtle protection center in Elota was established for a week during a conference held in Mazatlan on marine turtle conservation. Another small camp operated by SEPESCA at El Verde has been functioning for many years. Observers stated that these small centers are the beginnings of a much larger protection program in the state. The Mazatlan Aquarium opened an exhibit to heighten local awareness of the endangered status of sea turtles.

New NMFS Technical Reports Published

NOAA Technical Report NMFS 58. Vaughan, Douglas S. **"Stock Assessment of the Gulf Menhaden, *Brevoortia patronus*, Fishery."** September 1987, iii + 18 p., 19 figs., 14 tables.

ABSTRACT

A stock assessment of the Gulf menhaden, *Brevoortia patronus*, fishery was conducted with data on purse-seine landings from 1946 to 1985 and port sampling data from 1964 to 1985. These data were analyzed to determine growth rates, yield-per-recuit, spawner-recruit relationships, and maximum sustainable yield (MSY). Virtual population analysis was used to estimate stock size, year-class size, and fishing mortality rates. During the period studied an average of 27 percent of age-1 fish and 55 percent of age-2 and age-3 fish were taken by the fishery, and 54 percent for age-1 and 38 percent for age-2 and -3 fish were lost annually to natural causes.

Annual yield-per-recruit estimates ranged from 6.9 to 19.3 g, with recent mean conditions averaging 12.2 g since 1978. Surplus production models produced estimates of MSY from 620 to 700 kilometric tons. Recruits to age-1 ranged from 8.3 to 41.8 billion fish for 1964-82. Although there was substantial scatter about the fitted curves, Ricker-type spawner-recruit relationships were found suitable for use in a population simulation model. Estimates of MSY from population simulation model runs ranged from 705 to 825 kilometric tons with *F*-multiples of the mean rate of fishing ranging from 1.0 to 1.5.

Recent harvests in excess of the historical MSY may not be detrimental to the Gulf menhaden stock. However, one should not expect long-term harvesting above the historical MSY because of the short life span of Gulf menhaden and possible changes from currently favorable environmental conditions supporting high recruitment.

NOAA Technical Report NMFS 59. Smith, Joseph W., William R. Nicholson, Douglas S. Vaughan, Donnie L. Dudley, Ethel A. Hall. **"Atlantic Menhaden, *Brevoortia tyrannus*, Purse Seine Fishery, 1972-84, With a Brief Discussion of Age and Size Composition of the Landings."** September 1987, iii + 23 p., 3 figs., 12 tables, 14 appendix tables.

ABSTRACT

This report summarizes (1) annual purse seine landings of Atlantic menhaden, *Brevoortia tyrannus*, for 1972-84, (2) estimated numbers of fish caught by fishing area, (3) estimates of nominal fishing effort and catch-per-unit-effort, (4) mean fish length and weight, and (5) major changes in the fishery. During the 1970's stock size and recruitment increased and the age composition broadened, reversing trends witnessed during the fishery's decline in the 1960's. Landings steadily improved and by 1980 the total coastwide landings exceeded 400,000 metric tons. Nevertheless, the character of the fishery changed considerably. Eleven reduction plants processed fish at seven ports in 1972, but in 1984 only eight plants operated at five ports. Beginning in the mid-1960's the center of fishing activity shifted from the Middle Atlantic area to the Chesapeake Bay area, which has continued to dominate the fishery in landings and effort through the 1970's and 1980's. During this period the average size and age of fish in the catches declined.

NOAA Technical Report NMFS 60. Smith, Joseph W., Eldon J. Levi, Douglas S. Vaughan, and Ethel A. Hall. **"Gulf Menhaden, *Brevoortia patronus*, Purse Seine Fishery, 1974-85, With a Brief Discussion of Age and Size Composition of the Landings."** December 1987, iii + 8 p., 1 fig., 8 tables, 2 appendix tables.

ABSTRACT

Routine biostatistical port sampling data and landings records collected from the Gulf menhaden purse seine fishery between 1974 and 1985 are updated. During most of the period, a total of 11 menhaden reduction plants operated in Mississippi and Louisiana, and the number of vessels in the purse seine fleet varied from 71 to 82. Total annual landings ranged from 447,100 metric tons in 1977 to the record landings for the fishery of 982,800 metric tons in 1984. Age-1 and -2 Gulf menhaden annually comprised almost 96 percent of the landings. Estimated total numbers of menhaden landed varied from 4,510.5 million in 1975 to 11,154.9 million in 1985. Annual mean lengths and weights of sampled fish-at-age showed little variation. Nominal or observed fishing effort gradually

How to Leave a Stricken Vessel

"How to Abandon Ship" by Phil Richards and John J. Banigan, a popular wartime (WWII) handbook, has been reprinted by Cornell Maritime Press, Inc., P.O. Box 456, Centreville, MD 21617, as one of the Press' 50th Anniversary Commemorative Editions. Some of the information is, of course, dated, but much is timeless. Besides telling how to safely get off a vessel, it provides instructions on sea survival, navigation, seamanship, life rafts, medical needs, as well as tips on combatting thirst and hunger, icy weather, and maintaining morale.

Obviously out-of-date is the first aid material. However, the volume still has a lot of useful advice, particularly as regards preparedness: "Most casualties at sea are actually the result of panic, which is the result of ignorance." The basics of sea survival seem eternal, and this is an interesting and historic look at the topic that draws on some hard-earned knowledge. As the senior author wrote, "This manual is the result of open boat experience in the time of stress, danger, and sudden death. It contains no armchair theory. It is a digest of the lessons learned by the survivors of torpedoed ships." Paperbound and indexed, the small 152-page handbook is available from the publisher for $6.95.

increased through the 1970's and 1980's, reaching 655,800 vessel-ton-weeks in 1983.

NOAA Technical Report NMFS 61. Aebersold, Paul B., Gary A. Winans, David J. Teel, George B. Milner, and Fred M. Utter. **"Manual for Starch Gel Electrophoresis: A Method for the Detection of Genetic Variation."** December 1987, iii + 19 p., 8 figs., 1 table, 2 appendices.

ABSTRACT

The procedure to conduct horizontal starch gel electrophoresis on enzymes is described in detail. Areas covered are 1) collection and storage of specimens, 2) preparation of tissues, 3) preparation of a starch gel, 4) application of enzyme extracts to a gel, 5) setting up a gel for electrophoresis, 6) slicing a gel, and 7) staining a gel. Recipes are also included for 47 enzyme stains and 3 selected gel buffers.

NOAA Technical Report 62. Martin, Cynthia S., Shelley E. Arenas, Jacki A. Guffey, Joni M. Packard. **"Fishery Publication Index, 1980-85 Technical Memoradum Index, 1972-85."** December 1987, iii + 149 p.

ABSTRACT

The following series of fishery publications produced in calendar years 1980-85 by the Scientific Publications Office of the U.S. National Marine Fisheries Service (NMFS are listed numerically and indexed by author and subject: Circular, *Fishery Bulletin*, *Marine Fisheries Review*, Special Scientific Report-Fisheries, and Technical Report NMFS. Also included is an alphanumeric listing of the NOAA Technical Memoradum NMFS series published in calendar years 1972-85 by NMFS regional offices and fisheries research centers. Authors and subjects for the Memorandum series are indexed with the other publication series.

NOAA Technical Report NMFS 63. Vaughan, Douglas S., and Joseph W. Smith. **"Stock Assessment of the Atlantic Menhaden, *Brevoortia tyrannus*, Fishery."** January 1988, iii + 18 p., 17 figs., 13 tables.

ABSTRACT

A stock assessment of the Atlantic menhaden, *Brevoortia tyrannus*, fishery was conducted with purse-seine landings data from 1940 to 1984 and port sampling data from 1955 to 1984. These data were analyzed to determine growth rates, maximum sustainable yield (MSY), spawner-recruit relationships, and yield per recruit. Virtual population analysis was used to estimate stock size, year class size, and fishing mortality rates.

Surplus production models produced estimates of MSY from 450 to 490 kmt compared with yields of 416 to 436 kmt based roughly on maximum recruitment from a weak spawner-recruit relationship. Recruitment to age-1 ranged from 1.2 to 14.8 billion fish for year classes 1955-81. Recent mean recruitment to age-1 for the 1975-81 year classes averaged 5.7 billion fish and compared favorably with the mean of 7.7 billion age-1 fish recruited during the late 1950's. Mean recruitment from recent years suggests possible coastwide yields of 416 to 481 kmt. Continued dominance of late age-2 spawners among the spawning stock is of concern, since the stock is at greater risk through poor recruitment if recent favorable environmental conditions change.

Yield-per-recruit estimates ranged from 46 g to 59 g since 1970. The high dependency of the modern fishery on prespawners has increased concerns about fluctuations in year-to-year availability and catches. To increase yield and enhance the stability of the resource, the number of age classes contributing significantly to the fishery should be increased, creating a buffer against future poor recruitment years and lessening the year-to-year fluctuations in landings.

NOAA Technical Report NMFS 64. Farfante, Isabel Perez. **"Illustrated Key to Penaeoid Shrimps of Commerce in the Americas."** April 1988, iii + 32 p., 49 figs.

ABSTRACT

The commercially important species of penaeoid shrimps comprise 4 families, 12 genera, and 37 species in the Americas. This key is supported by 49 figures including lateral views of whole shrimps in 10 of the 12 genera and detailed figures of male (petasma) and female (thelycum) genital structures of the species. A glossary of terms used in shrimp taxonomy plus a bibliography of references useful in identifying shrimps are included.

NOAA Technical Report NMFS 65. Reeves, Randall R., and Edward Mitchell. **"History of Whaling in and Near North Carolina."** March 1988, iii + 28 p., 10 figs., 5 tables.

Studies in the Early Life History of Fishes

An attempt to compile an initial listing of articles and reports on marine recreational fisheries (MFR 49(2)) and on marine fisheries history (MFR 50(4)), makes it easier to understand the frustrations some have with the use of computerized databases, particularly for locating more obscure references and "gray" literature or informal publications. Some databases do not go back very far, some references are listed erroneously, some are missing, some are listed under the wrong categories, and printouts often contain many useless items.

To avoid such problems, Robert D. Hoyt of the Department of Biology, Western Kentucky University, Bowling Green, KY 42101, has compiled in one handy reference **"A Bibliography of the Early Life History of Fishes."** An immense amount of work has gone into this publication and the result—an indexed two-volume listing of nearly 14,000 titles—should be a great help for those working in this field. Beginning with a database provided by R. Kernehan of the AFS Early Life History Section, Hoyt consulted several other databases, surveyed existing bibliographies, and visited six major fisheries research institutions in the United States and Scotland to make detailed searches of their holdings of early life history literature in the summer of 1987. Indexed, cross-referenced, and easy to use, this two-volume set provides a comprehensive reference guide to the literature relating to the early life history of fishes for ichthyologists and fisheries libraries.

The literature (Volume I) is listed alphabetically by author, and includes 7,500 citations published since 1970; it is current to about summer 1987. Only 22 of the citations were undated; 10,166

ABSTRACT

This study reconstructs the history of shore whaling in the southeastern United States, emphasizing statistics on the catch of right whales, *Eubalaena glacialis*, the preferred target. The earliest record of whaling in North Carolina is of a proposed voyage from New York in 1667. Early settlers on the Outer Banks utilized whale strandings by trying out the blubber of carcasses that came ashore, and some whale oil was exported from the 1660's onward. New England whalemen whaled along the North Carolina coast during the 1720's, and possibly earlier. As some of the whalemen from the northern colonies moved to North Carolina, a shore-based whale fishery developed. This activity apparently continued without interruption until the War of Independence in 1776, and continued or was reestablished after the war. The methods and techniques of the North Carolina shore whalers changed slowly: As late as the 1890's they used a drogue at the end of the harpoon line and refrained from staying fast to the harpooned whale, they seldom employed harpoon guns, and then only during the waning years of the fishery.

The whaling season extended from late December to May, most successfully between February and May. Whalers believed they were intercepting whales migrating north along the coast. Although some whaling occurred as far north as Cape Hatteras, it centered on the outer coasts of Core, Shackleford, and Bogue banks, particularly near Cape Lookout. Capture of whales other than right whales was rare. The number of boat crews probably remained fairly stable during much of the 19th century, with some increase in effort in the late 1870's and early 1880's when numbers of boat crews reached 12-18. Then by the late 1880's and 1890's only about 6 crews were active. North Carolina whaling had become desultory by the early 1900's, and ended completely in 1917.

Judging by export and tax records, some ocean-going vessels made good catches off this coast in about 1715-30, including an estimated 13 whales in 1719, 15 in one year during the early 1720's, 5-6 in a 3-year period of the middle to late 1720's, 8 by one ship's crew in 1727, 17 by one group of whalers in 1728-29, and 8-9 by two boats working from Ocracoke prior to 1730. It is impossible to know how representative these fragmentary records are for the period as a whole. The Carolina coast declined in importance as a cruising ground for pelagic whalers by the 1740's or 1750's. Thereafter, shore whaling probably accounted for most of the (poorly documented) catch.

Lifetime catches by individual whalemen on Shackleford Banks suggest that the average annual catch was at least one to two whales during 1930-80, perhaps about four during the late 1870's and early 1880's, and declining to about one by the late 1880's. Data are insufficient to estimate the hunting loss rate in the Outer Banks whale fishery.

North Carolina is the only state south of New Jersey known to have had a long and well established shore whaling industry. Some whaling took place in Chesapeake Bay and along the coast of Virginia during the late 17th and early 18th centuries, but it is poorly documented. Most of the right whales taken off South Carolina, Georgia, and northern Florida during the 19th century were killed by pelagic whalers. Florida is the only southeastern state with evidence of an aboriginal (pre-contact) whale fishery. Right whale calves may have been among the aboriginal whalers' principal targets.

NOAA Technical Report NMFS 66. Allen, M. James, and Gary B. Smith. **"Atlas and Zoogeography of Common Fishes in the Bering Sea and Northeastern Pacific."** April 1988, iii + 151 p., 4 figs., 8 tables.

ABSTRACT

The geographic and depth frequency distribution of 124 common demersal fish species in the northeastern Pacific were plotted from data on file at the Northwest and Alaska Fisheries Center (NWAFC), National Marine Fisheries Service. The data included catch records of fishes and invertebrates from 24,881 samples taken from the Chukchi Sea, throughout the Bering Sea, Aleutian Basin, Aleutian Archipelago, and the Gulf of Alaska, and from southeastern Alaska south to southern California. Samples were collected by a number of agencies and institutions over a 30-year period (1953-83), but were primarily from NWAFC demersal trawls. The distributions of all species with 100 or more occurrences in the data set were plotted by computer.

Distributions plotted from these data were then compared with geographic and depth-range limits given in the literature. These data provide new range extensions (geographic, depth, or both) for 114 species. Questionable extensions are noted, the depth ranges determined for 95 percent of occurrences, and depths of most frequent occurrence are recorded.

Ranges of the species were classified zoogeographically, according to life zone, and with regard to the depth zone of greatest occurrence. Because most species examined have broad geographic ranges, they do not provide the best information for testing the validity of proposed zoogeographic province boundaries. Because of the location of greatest sampling effort and methods used in sampling, most fishes examined were eastern boreal Pacific, sublittoral bathyal (outer shelf) species.

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were published since 1960, and 2,182 were published before 1950. Listed also are 458 titles published prior to 1900. The Index (Volume II) is presented as five Appendices, with four short and simple: B and C, scientific and common names, respectively; D, family name index; and E, location (geographic) index. Appendix A is the huge 404-page subject index ranging from "aberrant gene expression" to "zuger glasses." Like a dictionary, the indexes have header words to identify the starting and ending words for the page.

There are some minor inconsistencies in author's name spellings and in titles, but that should not be a big problem. Some of the index cross-referencing is not as complete as it could have been, but researchers should be able to overcome that by checking the potential keywords for the topic(s) in which they are interested. The author candidly points out other "shortcomings," such as an incomplete collection of salmonid literature and the limited availability of Japanese, South Pacific, and Russian titles—primarily owing to lack of library holdings and/or English translations. Indeed, the few "shortcomings" in this reference work should be far outweighed by its utility.

It grows ever more difficult to get established publishers to print works like this one, owing to the size, cost, and often a limited audience. Thus, the Author took the unusual move to publish it himself and, all things considered, has done a commendable job. Volume I is 525 pages and Volume II is 448 pages, with plastic binding, paper covers, and the set may be ordered directly from the author, Robert D. Hoyt, Dept. of Biology, Western Kentucky University, Bowling Green, KY 42101 at $55.00 plus $5.00 postage for orders outside the United States (make checks payable in U.S. currency or the equivalent).

The Future of the Atlantic Salmon

"Atlantic Salmon: Planning for the Future," edited by Derek Mills and David Piggins, has been published by Timber Press, 9999 S.W. Wilshire, Portland, OR 97225. Mills is with the Department of Forestry and Natural Resources, University of Edinburgh, and Piggins is with The Salmon Research Trust of Ireland; the volume was published on behalf of the Atlantic Salmon Trust. The book presents papers from the Third International Atlantic Salmon Symposium held in Biarritz, France, in October 1986, and constitutes a major international review of the biology, management, and conservation of *Salmo salar*; it should be a useful reference for those interested in or involved with studying or managing the species.

The book's 30 papers are divided into five parts. In Part I, papers of interest include a review of NASCO and progress in salmon management under it, the EEC's approach to international salmon management, and a presentation on steps taken by Canada and the United States in Atlantic salmon protection and restoration. Papers in Part II review the status of exploitation in all areas of the Atlantic salmon's range, and recent management measures for commercial and sport fishing.

Papers in Part III relate problems in obtaining and using catch records, relating catch records to stocks, measuring spawning escapement, salmon stock enhancement, review of a number of salmon restoration programs, and methods of assessing or predicting Atlantic salmon abundance. Part IV reviews the exploitation and migrations of the Atlantic salmon on the high seas and off Greenland, in Faroese waters, and the ocean life of the species in the Northwest Atlantic. Another paper identifies some of the most important gaps in knowledge about the species' marine life and suggests studies to fill in the gaps.

Finally, Part V discusses the important impact of illegal fishing on Atlantic salmon in Norway and Ireland, along with problems associated with seemingly unregulated fishing in certain areas by Native Americans in eastern Canada. Final recommendations include 1) Investigation by NASCO of a salmon tagging scheme for more reliable collection of catch data and better control of illegal fishing; 2) that drift and hang nets (except operations off Greenland) be phased out; 3) that EEC funds be made available to improve and coordinate national salmon fisheries inspectorates; and 4) that each Atlantic salmon nation encourage the introduction of a reasonable daily and season rod-catch quota, prohibit the sale of the catch, and consider the adoption of a "catch and release" philosophy. Finally, the symposium and the book closes with a Resolution: "That each salmon-producing national government is urged to declare a salmon policy which will institute, as a conservation measure in its waters, management programs to reduce commercial harvesting of salmon with a view to increasing salmon stocks and improving recreational salmon fisheries." Indexed, the 587-page hardbound volume is available from the publisher for $69.95 plus $3.00 shipping for the first book and $2.00 for each additional volume.

The Identification of Fish Stocks

The identification of discrete fishery resource units is crucial to the effective fishery management. Toward that end, a workshop was organized by the Panama City Laboratory of the NMFS Southeast Fisheries Center in late 1985 to review and discuss the advances in techniques and equipment for stock identification, and the results have now been published as **"Proceedings of the Stock Identification Workshop,"** Herman E. Kumpf, editor-in-chief. Other members of the editorial committee included Rosalie N. Vaught, Churchill B. Grimes, Allyn G. Johnson, and Eugene L. Nakamura.

The major objective of the workshop was to gain a more comprehensive understanding of stock identification problems and approaches to their solutions, and the Proceedings should be of wide interest and use to scientists and fishery managers. For the Plenary session invited speakers produced six critical reviews of both traditional and innovative stock identification methods; those contributions received peer reviews and editing. Section two of the proceedings presents 19 abstracts of contributions on innovative techniques and their applications to fishery stock problems. A final section of interest is the panel discussion, including exchanges from the floor of thoughts, ideas, and commentary.

In the lead Plenary Session paper, Brad Brown, George Darcy, and William Overholtz reviewed some of the major marine fishery assessment problems in the southeastern United States related to stock identification, along with some historical stock-assessment/identification interaction case studies. Gary Winans then discussed the use of morphometric and meristic characters for identifying fish stocks, focusing on types of characters, data collection procedures, and statistical analyses, and using examples of his studies of milkfish and chinook salmon.

A paper by Fred Utter outlines the applications of genotypic and allelic data obtained by protein electrophoresis in fish stock identification, and John C. Avise reviews identification and interpretation of mitrochondrial DNA stocks in marine species, suggesting fruitful areas for future research. Ronald C. Lundstrom then discusses the potential use of monoclonal antibodies for identification of fish stocks. Finally, Saul Saila and Brooks Martin present a review and guide to some multivariate methods for stock identification.

Information on availability of the 228-page paperbound volume, NOAA Technical Memorandum NMFS-SEFC-199, is available from the NMFS Panama City Laboratory, 3500 Delwood Beach Road, Panama City, FL 32407-7499. Copies of volumes in this NOAA Technical Memorandum series, if out of print, are always available in either microfiche or hard copy from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

The Variability and Quality of Fish Flesh

Publication of **"The Food Fishes, Their Intrinsic Variation and Practical Implications"** by R. Malcolm Love of the Torrey Research Station in Scotland has been announced by the Van Nostrand Reinhold Company, 115 Fifth Avenue, New York, NY 10003 (as an AVI book imprint), Fish, as a raw material, is inherently variable—the fishes themselves vary greatly in size, shape, microbiology, chemistry, biochemistry, etc., not to mention by season of catch. This book deals uniquely with the chemical and biochemical variations in fishes and should help to advance their utilization. Rather than presenting an assemblage of tables and figures, the author has here chosen to explain the variability of fish in terms of the underlying physiological changes, of external influences, and of biochemical responses to them.

The review is divided into three sections: Part I, the fish themselves, discusses the physical structure of fish muscle and its chemistry, growth and aging, maturation and spawning, recovery from starvation, and fish diet. Part II relates aspects of fish quality—texture, color, flavor, and gaping. Chapters deal with the nature, causes and alleviation of gaping, natural variations in the responses of fish muscle to cold storage, and the nature of freezing. Each chapter is wrapped up with a section entitled "Technological Perspectives" to review and assess the salient points. And, Part III discusses the environmental factors influencing fish quality (i.e., depth, pH, water movement, crowding, salinity, oxygenation, temperature, stress, and fishing grounds conditions).

Also provided is an appendix of common and scientific names of fish mentioned in the text, a glossary of technical terms, a list of references and an author index (with page numbers where the author has been quoted or cited in the text), and a subject index. The author has drawn together a considerable amount of material, much fairly recent, and assessed and presented it in a manner which should be both interesting and useful for nutritionists, food technologists, and food scientists as well as fish culturists. Hardbound, the 276-page volume is available from the publisher for $49.95; in the United Kingdom it is published by Farrand Press, London.

Regional Guides to Marine Fishes

"Coastal Fishes of the Pacific Northwest" by Andy Lamb and Phil Edgell has been published by Harbour Publishing Co., Ltd., P.O. Box 219, Madeira Park, B.C., Canada V0N 2H0, and is a very well illustrated handbook of that region's marine fishes for anglers, commercial fishermen, scuba divers, and biologists. It would be especially useful for its individual color photographs of 174 species, which are numbered to correspond with the species listings. The photographs were made in natural settings—not a studio—which gives a better picture of each species' typical habitat.

Species are presented by family, with a brief discussion of each family and a representative line drawing. General information is given on pertinent biological and ecological data, world-wide distribution, size, its largest member, its history, importance to man, and distinctive features. Although there is no "key to fishes" per se, fishes similar in appearance are grouped together; thus, readers can use the photographs and drawings as a form of "visual" key, along with descriptions to identify them.

Accepted common and scientific names, along with "alternate" or other local names are given in the species accounts. A pencil drawing illustrates special identifying features for each species, and data is given on maximum recorded sizes and distribution. Specific information is given for anglers, scuba divers, commercial fishermen, beachcombers or tide pool observers, along with cautionary data for hazardous species along with tips on kitchen preparation of edible species. Indexed, the book also includes selected references for further reading or data, and it would be useful, generally, from about northern California into southeastern Alaska. Cost of the 239-page paperbound volume is $29.95.

A smaller and more specific guide to problem species is **"Dangerous Marine Animals of the Pacific Coast"** by Christina Parsons and published by Sea Challengers, 4 Somerset Rise, Skyline Forest, Monterey, CA 93940. This is a very general guide to problem marine animals in that its data on the toxins involved is not specified; the reader is only told that a species is toxic and then is given first aid treatment instructions. It goes beyond just the toxic species, however, to include sections on mammals, fishes, and invertebrates which may bite, shock, have a venomous spine or sting, and those which are poisonous to eat. The problem species are illustrated and described, along with the potential hazard, how to avoid it, what the symptoms are, and what the first aid treatement is. It would be useful for anglers, commercial fishermen, divers, and others who may come in contact with potentially hazardous west coast marine life. The small, paperbound, 96-page volume is available from the publisher for $4.95.

"Fishes of the Gulf of Mexico" by H. Dickson Hoese and Richard H. Moore is subtitled "Texas, Louisiana, and Adjacent Waters," and is published by the Texas A&M University Press, Drawer C, College Station, TX 77843. Underwater photographs in the volume were made by Farley Sonnier, and it is number one in the W. L. Moody, Jr., Natural History Series. With more than 600 photos and drawings (more than 330 color photos alone including many excellent underwater shots), this authoritative volume clearly and excellently illustrates about 500 marine fishes in the Gulf waters of Texas and Louisiana, though it would, of course, be useful well beyond those two states.

Keys are also provided, first, to determine the family, then to identify the genus and species. Each fish is described, giving common and scientific names, identifying characteristics (spine, ray, and scale counts), abundance, importance, habitat, geographic

range, and approximate maximum size. For nontechnical readers, an illustrated glossary is helpful.

Introductory chapters discuss environmental variables affecting the region's fishes, as well as aspects of zoogeography, conservation efforts, regional history of ichthyological research, and methods to use in identifying fish. Then follow the color illustrations, and the family and species accounts. Indexed, the 327-page volume is available from the publisher at $19.95 (cloth) and $9.95 (paper).

Coastal and Estuarine Studies Published

Construction of the Calvert Cliffs nuclear power plant on the western shore of the Chesapeake Bay, Maryland, provided an opportunity for study and assessment of the potential effects that operation of the Calvert Cliffs Nuclear Power Plant (CCNPP) might have on the mid-portion of that important bay system, by scientists from The Academy of Natural Sciences of Philadelphia. Major biotic components of the system were studied over an area and time period sufficient to allow comparison of conditions before and after power plant operation had begun.

"Ecological Studies in the Middle Reach of Chesapeake Bay (Calvert Cliffs)", edited by Kenneth L. Heck, Jr., and published by Springer-Verlag, 175 Fifth Avenue, New York, NY 10010, is an excellent summary of those studies. Elements chosen for detailed research included species composition and production rates of major primary producers, water chemistry, zooplankton, benthos, and finfish abundance and species composition; the abundance and growth rates of commercially important shellfish (clams, oysters, and blue crabs); and the colonization sequences of invertebrates on artificial substrates.

The studies document and provide important data on long-term patterns and trends for the area, and allow the characterization of dominant physical, chemical and biological processes in the area. They also facilitate the exploration of relationships between nutrient availability and primary production, between primary and secondary production, and between climatic variation and biological response. The volume also summarizes the effects of the nuclear plant operations on the Bay ecosystem, evaluates the general significance of the findings, and gives some recommendations for further studies of impacts on estuarine systems. Paperbound, the 287-page volume is number 23 in the Springer-Verlag series "Lecture Notes on Coastal and Estuarine Studies," and is available from the publisher.

Number 24 in the same series is **"Environmental Studies in Port Valdez, Alaska, A Basis for Management,"** edited by David G. Shaw and Mohammad J. Hameedi. When the Port of Valdez, Alaska, was chosen as the terminus of the Trans-Alaska Pipeline, it provided researchers with a unique opportunity to study an essentially pristine marine system and measure any changes over time owing to environmental disturbance. Highly treated oil tanker ballast water, millions of gallons of, would be discharged each day with still 8-10 parts per million of the most soluble fraction of petroleum, meaning that 8-10 barrels of those hydrocarbons would be discharged daily. Preliminary biological studies began in 1969, followed by a major oceanographic study from May 1971 to April 1972. In March 1976 field work resumed and continued through November 1978, during which time the tanker terminal became operational.

This volume reviews and analyzes the information gathered through those and related studies at Port Valdez. Some of the general conclusions drawn to date are that: Ballast discharge has created no ecologically or socially significant biological change; flushing of Port Valdez and nutrient input and cycling, is heavily influenced by storm patterns; the energy producing regime (phytoplankton and macrophytes) and the primary grazing regime (zooplankton and micronekton) changed dramatically between the before- and after-operation studies; and relatively little hydrocarbon contamination of the sediments is found in Port Valdez (as compared with other oil contaminated regions). Three final chapters discuss scientific, technical, and regulatory considerations in environmental management; use of scientific information by managers; and lessons gained from the Port Valdez studies. The 423-page paperbound volume is available from the publisher.

The Regulation of Marine Populations

Number one in a series "Books in Recruitment Fishery Oceanography" is **"Marine Populations, An Essay on Population Regulation and Speciation"** by Michael Sinclair and published by the Washington Sea Grant Program, University of Washington, 3716 Brooklyn Avenue, N.E., Seattle, WA 98105. The author is a marine biologist with the Canadian Department of Fisheries and Oceans and is on the staff of the Halifax Fisheries Research Laboratory. His book is an outgrowth of a series of lectures on the topic that he delivered in 1985 at a new U.W. Sea Grant Seminar Series by the same title.

In introducing the new series, "recruitment fishery oceanography" is defined as "the study of the effects of environmental variability on year class strength, or recruitment, in populations of marine organisms, especially those of commercial importance." Such studies are concerned with the factors that determine the productivity of living resources under environmental and fishing stress, and they also touch on a wide variety of disciplines, such as physical, chemical, and biological oceanography, as well as fishery science, meteorology, and more. Thus, the lectures and this book present a very interesting perspective on the topic of population biology and regulation.

Chapter 3 presents a fairly detailed review of recent developments on the population biology of Atlantic herring. The member/vagrant hypothesis is presented in chapter 4 and in the following 3 chapters the author reviews aspects of the fisheries, estuarine, oceanic island,

zooplankton, and benthos literature to provide support for the member/vagrant hypothesis, concluding with a summary in chapter 8. Assuming support for the hypothesis, the author next discusses implications for selected ecological issues. He highlights pattern, richness, and abundance, rather than variability, in his treatment of population regulation.

In the last three chapters the author discusses the implications for evolutionary theory. The discussions are presented more in essay form and argue a particular point of view not shared by all scientists, but which should help advance discussions and perhaps point out useful avenues for future research. Indexed and with extensive references, the 252-page volume is available from the publisher at US$15.00 (paper) and US$25.00 (cloth).

Marine Invertebrate Reproduction Reviews

"Reproduction of Marine Invertebrates, Volume IX, General Aspects: Seeking Unity in Diversity," edited by Arthur Giese, John Pearse, and Vicki B. Pearse, has been published by Blackwell Scientific Publications, Inc., 667 Lytton Avenue, Palo Alto, CA 94301. This volume is a fine and up-to-date systematic review of major aspects of reproduction for all the phyla of free-living marine invertebrates. Five volumes have already been published in the series on metazoans, coelomates, annelids and echiurans, gastropods and cephalopods, and pelecypods and lesser molluscan classes; volumes on lophophorates and echinoderms, nonmalacostracan arthropods, and malacostracan arthropods remain in press.

Gamete production—the start of sexual reproduction—is the subject of the first two chapters, gametogenesis and oogenesis, in which the authors demonstrate that, despite the wide diversity among metazoans, gametogenesis and the final form and function of gametes are quite uniform and provide a sound basis for broad generalizations. The next two chapters provide a look at the complexity of endocrine control of gametogenesis and spawning, and the synchronozation of these processes for all metazoans. Chapter 5 then discusses chronobiology, presenting methods for computer analysis of reproductive periodicities in marine invertebrates.

Additional chapters then draw together much recent information on different aspects of larval biology. Chapter 6 reviews the literature pertaining to abundance and distribution of pelagic larvae in the plankton, and much of chapter 7 concerns the feeding mechanisms and feeding rates of different larval forms. Chapter 8 discusses environmental influences (i.e., food quality and quantity, temperature, salinity, and other factors) on larval survival and rate of development. Finally, chapter 9 strives to interrelate the material provided in the other chapters and volumes by reviewing and discussing evolutionary aspects of marine invertebrate reproduction. The 712-page hardbound volume has taxonomic, author, and subject indexes and is available from the publisher for $50.00.

Managing Fishes in Large Reservoirs

Publication of **"Reservoir Fishery Management and Development in Asia"** edited by Sena S. De Silva, has been announced by the International Development Research Center, P.O. Box 8500, Ottawa, Canada K1G 3H9. The volume constitutes the proceedings of a workshop held in Kathmandu, Nepal, on 23-28 November 1987, where representatives from 15 nations reviewed the status of reservoir fishery research in Asia, particularly as related to the present status of fisheries, limnological aspects, biological and resource aspects, management aspects, and fish culture. Summaries of pertinent discussion sessions are also included. The volume emphasizes the potential for increased fish production in reservoirs and the need for early involvement of fisheries scientists in the planning and in preimpoundment studies before dam construction.

Also discussed are aquaculture strategies and techniques in Chinese, Sri Lankan, and Indonesian reservoirs. In some countries, such as Nepal, planning will be most advantageous; that nation currently has just 1,500 ha of reservoir surface area but anticipates growth to more than 200,000 ha by the year 2000. The 246-page paperbound volume, IDRC-264e, is available from the publisher (price not listed).

The Coastal Resources of Brunei Darussalam

"The Coastal Environmental Profile of Brunei Darussalam: Resource Assessment and Management Issues," edited by Chua Thia-Eng, Chou Loke Ming, and Marie Sol M. Sadorra, has been published as ICLARM Technical Reports 18 by the Fisheries Department, Brunei Darussalam, and the International Center for Living Aquatic Resources Management, MC P.O. Box 1501, Makati, Metro Manila, Philippines.

Brunei Darussalam is moving to diversify its economy, and this publication reviews and analyzes the nation's physical environment, coastal resources, population, land use and development, economics, pollution problems, institutional and legal framework, and coastal resources and management issues. Paperbound, the 192-page volume is available from ICLARM at $2.00 (surface mail) and $10 (airmail); ordering via airmail is recommended by the Center.

On Omega-3 Fatty Acids

The keynote address in the MIT Sea Grant Lecture and Seminar Series on the health effects of omega-3 fatty acids is **"The Impact of Dietary Fat on Human Health"** by Robert S. Lees, Professor of Cardiovascular Disease at MIT. Published as MITSG 88-3 by the MIT's Sea Grant Program, Building E38-300, 292 Main Street, Cambridge, MA 02139, it addresses the question, "Can eating fish reduce the risk of heart disease?"

Discussed are aspects of human fat

metabolism, dietary fat intake and disease, and dietary fat and individual diseases, the author provides a succinct look at the three major diseases to which dietary fat has been linked (cardiovascular disease, cancer, and arthritis). He has reviewed epidemiological, biochemical, physiological, and pathological evidence to conclude that the types and amounts of fat in the human diet are clearly associated with heart disease, less so with cancer, and may have some therapeutic effects on rheumatism and arthritis. Other aspects of the healthful benefits of fish oils, the author finds less conclusive. Single copies of the 28-page paperbound booklet are free; additional copies are $2 each.

Shellfish Depuration Conference

Plans for the "First International Conference on Shellfish Depuration" have been announced, and it is scheduled for 5-8 November 1989 at Grosvenor (Walt Disney Village) Resort in Orlando, Fla. Topics to be discussed include national and international overviews, legal aspects, marketing considerations, economic evaluations, water quality and treatments, design and engineering criteria, bacterial and viral monitoring, regulatory methods, etc. The conference is being organized by the Florida Sea Grant Program and the National Fisheries Institute, in cooperation with several other associations and agencies concerned with shellfish quality and safety. A conference proceedings will be published too. For further information contact Steven Otwell, 467 Food Science Building, University of Florida, Gainesville, FL 32611, or telephone 904-392-1991, or FAX 904-392-8594.

Errata

In the article "The traditional central California setnet fishery" by Edward Ueber in the *Marine Fisheries Review* 50(2):40-48, the name listed in the abstract and text for halibut was incorrect. The correct species is the California halibut, *Paralichthys californicus* (Ayers). Also, in the abstract, the name for the white croaker should read *Genyonemus* instead of *Gengonemus*.

Editorial Guidelines for the *Marine Fisheries Review*

The *Marine Fisheries Review* publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under a completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgments" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

Style

In style, the *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 12, "A List of Common and Scientific Names of Fishes from the United States and Canada," fourth edition, 1980. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

Tables and Footnotes

Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

Literature Cited

Title the list of references "Literature Cited" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, and the year, month, volume, and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

Citations should be double-spaced and listed alphabetically by the senior author's surname and initials. Co-authors should be listed by initials and surname. Where two or more citations have the same author(s), list them chronologically; where both author and year match on two or more, use lowercase alphabet to distinguish them (1969a, 1969b, 1969c, etc.).

Authors must double-check all literature cited; they alone are responsible for its accuracy.

Figures

All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8 × 10 inches, sharply focused glossies of strong contrast. Potential cover photos are welcome, but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

Line art should be drawn with black India ink on white paper. Design, symbols, and lettering should be neat, legible, and simple. Avoid freehand lettering and heavy lettering and shading that could fill in when the figure is reduced. Consider column and page sizes when designing figures.

Finally

First-rate, professional papers are neat, accurate, and complete. Authors should proofread the manuscript for typographical errors and double-check its contents and appearance before submission. Mail the manuscript flat, first-class mail, to: Editor, *Marine Fisheries Review*, Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Bin C15700, Seattle, WA 98115.

The senior author will receive 50 reprints (no cover) of his paper free of charge and 50 free copies are supplied to his organization. Cost estimates for additional reprints can be supplied upon request.

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ISSN 0090-1830

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